# Mosses of the Great Lakes Forest

by

Howard Crum

# MOSSES OF THE GREAT LAKES FOREST

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University of Michigan

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## TABLE OF CONTENTS


Introduction . . . . . 1
Key to the Genera of Michigan Mosses . . . . . 3
Systematic Account . . . . . 17
SPHAGNOPSIDA . . . . . 17
ANDREAEOPSIDA . . . . . 50
BRYOPSIDA . . . . . 51
Fissidentaceae . . . . . 51
Bryoxiphiaceae . . . . . 62
Seligeriaceae . . . . . 62
Ditrichaceae . . . . . 65
Dicranaceae . . . . . 74
Leucobryaceae . . . . . 92
Encalyptaceae . . . . . 94
Pottiaceae . . . . . 97
Grimmiaceae . . . . . .119
Hedwigiaceae . . . . . .129
Funariaceae . . . . . .130
Ephemeraceae . . . . . .139
Splachnaceae . . . . . .140
Schistostegaceae . . . . . .144
Bryaceae . . . . . .148
Mniaceae . . . . . .165
Timmiaceae . . . . . .179
Aulacomniaceae . . . . . .181
Meesiaceae . . . . . .185
Catoscopiaceae . . . . . .189
Bartramiaceae . . . . . .190
Orthotrichaceae . . . . . .194
Cryphaeaceae . . . . . .208
Leucodontaceae . . . . . .209
Fontinalaceae . . . . . .213
Neckeraceae . . . . . .218
Fabroniaceae . . . . . .221
Leskeaceae . . . . . .224
Amblystegiaceae . . . . . .249
Brachytheciaceae . . . . . .280
Entodontaceae . . . . . .304
Plagiotheciaceae . . . . . .306
Sematophyllaceae . . . . . .310
Hypnaceae . . . . . .314
Climaciaceae . . . . . .335
Hylocomiaceae . . . . . .339
Buxbaumiaceae . . . . . .345
Diphysciaceae . . . . . .348
Tetraphidaceae . . . . . .350
Polytrichaceae . . . . . .351
A Dictionary of Terms Relating to Mosses . . . . . .365
Bibliography . . . . . .379
Index . . . . . .399

# INTRODUCTION

The mosses of the Douglas Lake region have been studied with care and enthusiasm for half a century, and more. Getting to know them has given me many happy summers. Because of my efforts and the efforts of others, the flora has been very completely inventoried. It is not the richest flora in the country by any means, but the mosses are a conspicuous and attractive feature of the vegetation and surprisingly numerous and interesting–yet not so numerous as to plague the student with unusual problems in variation and intergradation. It is to the student that this book is directed. It is to my family–to Irene, Mary, and Roger–that it is dedicated.

The local area has had rough treatment from man and nature. Scraped clean by glaciation and flooded by post-glacial lakes, the land became available to plants only about 10,000 years ago, some of it about 2500 years ago. Habitat diversity is limited. The land has only slight relief, and the soils are mostly calcareous sands or lowland peat. Scarcely any rock is exposed in Emmet and Cheboygan Counties, but in nearby Mackinac and Presque Isle Counties limestone outcrops in occasional dry pavements or low cliffs. Glacial erratics present some variety in substrate, of slight importance. Streams are few, owing to porous sands and limey bedrock. The winters are harsh and the summers short, providing comfort only to the hardy or the indifferent.

The flora is representative of the entire Great Lakes Basin and St. Lawrence River Valley. This is the area occupied by the Great Lakes Forest, which in aboriginal time consisted of a mixed forest of beech and sugar maple (interspersed with yellow birch and hemlock) on better upland soils, various pines (jack, red, and white) on sandy uplands, and swamp forests (elm-ash-red maple; spruce-tamarack; and white cedar-fir) in lowlands. This forest complex, lying in a tension zone between the oak-hickory and northern coniferous forests, occupies the northern half of Michigan's Lower Peninsula and some of the Upper Peninsula. It is Michigan's cool North Woods. In the Douglas Lake region the lowlands have escaped disturbance until very recently. Extensive road building has had dire effects on drainage and altered swamplands of all kinds, and the Dutch Elm disease has drastically changed the character of hardwood swamps within the past 30 years. The uplands have been subject to misuse for a century or more, in the form of lumbering, burning, farming, road-building, and cottage living, not to mention the recreational assaults of recent years. The uplands are now, except for limited acreage in farmland, in a process of regeneration from a pioneering aspen-red maple stage through a red oak-pine mixture to a closed forest dominated by beech and sugar maple.

This is a land of lakes. The most beautiful habitats are the many peat bogs at the edges of pot-hole lakes, eventually transforming them into black spruce muskeg, the forest climax on acid peat. Our bogs, fed by ground water and therefore minerotrophic, are more properly considered rich or poor fens, depending on the stage of succession toward drier and more acid conditions. Succession is often cyclic rather than directional, and so the story-book progression from open water to muskeg is, more often than not, only a theoretical possibility. *Sphagnum* creates an acid habitat and controls the vegetation of bogs at every stage of development.

The *Thuja* swamps provide the richest habitat for mosses. Developed as the climax forest on the calcareous soils wetted by a changing water table, they are successional to sedgey fens, in stream valleys, at edges of lakes fed by streams, and along the margins of beach pools at the sandy shores of the Great Lakes. A few species of *Sphagnum* occur in open fens, and some characterize the woodland climax, but they scarcely dominate or control any stage of succession. The beach pools harbor at their

margins an assemblage of rare northern disjuncts—the same group of species deposited as fossils in the Cheboygan County Bryophyte Bed 13,000 years ago during the final withdrawal of Pleistocene ice.

This book was written especially for students at the University of Michigan Biological Station. It includes all the mosses from the area of the Straits of Mackinac, arbitrarily delimited as Cheboygan, Emmet, Mackinac, and Presque Isle Counties because of easy access from the station. The book is also tailored for use in a broader area, in much of eastern North America, in fact. The introductory key includes all Michigan genera, and the text gives incidental means of identifying all of Michigan's mosses and most of those of the entire Great Lakes-St. Lawrence River area. It provides a personalized guide to the literature on the biology of mosses, with references to the kind of thing that gives meaning to a field-oriented course in taxonomy. The glossary is a complete dictionary of terms used in the literature to describe mosses included here because good students always find use for other manuals and specialized works on taxonomy. References are given to illustrations in manuals likely to be available to students. Most of the illustrations in this book are my own. Some were done by Michelle Smith, who also made the cover design. A few of the drawings were adapted from pencil sketches made by Marilou Florian.

I owe gratitude to the many people, teachers and students, who have left collections in the herbaria of the University of Michigan, the Biological Station, and elsewhere. Bryology at the Biological Station dates back to 1918 when George E. Nichols visited there in search of a good source of *Sphagnum* for use in making wartime surgical pads. He offered a course in bryology from 1920 until 1938. (An announcement in *The Bryologist* that the course would be offered for the second time in 1921 tells us that "despite unfavorable first impressions, Dr. Nichols found the region bryologically quite rich.") William C. Steere took over from 1939 to 1942 and (after taking part in a *Cinchona* mission in South America) again in 1945 and 1946. Margaret Fulford offered the course from 1947 to 1949 and 1951 to 1953. Paul M. Patterson taught in 1950 and A. J. Sharp from 1954 to 1957 and 1959 to 1964. I taught the course in 1958 (when I began this book) and from 1965 through 1972. Dale H. Vitt replaced me during part of 1971 when I became ill.

I cannot thank every person who has helped me to know the mosses of the Great Lakes Forest. I am, above all, grateful to William C. Steere, who directed me in graduate study at the University of Michigan. He showed me far horizons and gently pushed me toward them. His friendly concern has continued through the years. Lewis E. Anderson has made many direct and indirect contributions to this study which is, in a sense, a by-product of a larger flora which we are writing together. He spent a summer with me at the Biological Station; then, as always, his light-hearted approach to study made work fun. Wolfgang Maass also spent a summer at the station and taught me much about *Sphagnum*. Harold Robinson, Norton G. Miller, Jerry A. Snider, and Dale H. Vitt have been good friends and good companions in the field. Margaret Fulford was my first teacher in bryology and first showed me the moss flora of northern Michigan. A. J. Sharp found many rarities in the area and has been a constant source of help and encouragement over many years. I got good ideas on resources in the literature from Harvey A. Miller.

This work was done at the Herbarium of the University of Michigan, at the Biological Station, and also at the National Museum of Canada.

I am indebted to the Rackham School of Graduate Studies, University of Michigan, for two faculty research grants (NSF Institutional Grants 96 and 149) and also, less directly, to the National Science Foundation for Grant GB-6095, which provided funds for workshops in bryology at the Biological Station.

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## KEY TO THE GENERA OF MICHIGAN MOSSES

1. Leaf cells arranged in a network of narrow, green cells enclosing large hyaline cells
*Sphagnum*, p. 17

1. Leaf cells not arranged in a network
2. Costa covered by green lamellae
3. Leaves rigid wet or dry, broad and sheathing at base; costa broad, occupying most of the leaf above the shoulders, covered by 16-60 lamellae; calyptra densely hairy
4. Capsules angled, cubic or prismatic, inclined, smooth *Polytrichum*, p. 355
4. Capsules not angled, cylindric, either erect, symmetric, and mammillose-roughened or inclined, curved-asymmetric, and smooth *Pogonatum*, p.361
3. Leaves soft, shriveled or otherwise contorted when dry, not broadly sheathing at base; costa narrow; lamellae 2-6, rarely 9; calyptra naked
5. Plants relatively coarse, of medium size, tufted; leaves undulate, bordered by linear cells, doubly serrate, not ending in an awn; peristome of 32 short teeth attached at their tips to a membranous expansion of the tip of the columella *Atrichum*, p. 352
5. Plants small, scattered; leaves not undulate, bordered, or serrate, ending in an awn; peristome none (or rudimentary), the tip of the columella not expanded as a membrane *Pterygoneurum*, p. 119
2. Costa not lamellose
6. Leaves several layers thick, consisting mainly of costa (which is 1/3-2/3 or more the width of the leaf base and fills most of the subula), in section showing both hyaline and green cells
7. Plants whitish; leaves consisting almost entirely of costa, in section showing several layers of hyaline cells enclosing a ± median row of smaller, green cells; alar cells not differentiated *Leucobryum*, p. 92
7. Plants greenish or brownish; leaves consisting of a broad costa occupying 1/2-2/3 the leaf base and most of the subula, in section showing hyaline cells on either side of a median row of green cells (in our species also with green and hyaline cells on the lower surface arranged in alternating longitudinal rows giving the leaves a striate appearance under a lens); alar cells differentiated *Paraleucobryum*, p. 89
6. Leaves unistratose (or rarely ± thickened at the apex or along the margins); costa narrower (or lacking), not showing hyaline and green cells in section
8. Plants dark (brown, reddish, or blackish), brittle when dry, growing on granitic rock; capsules sessile, elevated at maturity on an extension of the stem, dehiscing by 4 longitudinal slits *Andreaea*, p. 50
8. Plants generally not particularly dark or brittle, on various substrates; capsules, if exserted, not elevated on an extension of the stem, operculate or indehiscent (not dehiscing by longitudinal slits)
9. Leaves obviously inserted in 2 rows
10. Leaves appearing split at the base, consisting of 2 vaginant laminae which clasp the stem and the base of the leaf above, with wing-like extensions apically and dorsally *Fissidens*, p. 51
10. Leaves not differentiated into vaginant, apical, and dorsal laminae
11. Plants dimorphous (fertile plants with leaves crowded at the apex, the sterile plants with leaves in 2 rows and connected by broad decurrencies); leaves not sheathing or subulate; plants of dark places (especially caves), with a luminous protonema *Schistostega*, p. 144
11. Plants not dimorphous; leaves sheathing at base and narrowed to a linear subula or awn; plants not growing in dark places, the protonema not luminous
12. Leaves contracted to a rough, linear subula; capsules exserted; peristome present *Distichium*, p. 67
12. Leaves ending in a smooth awn (increasingly longer toward the stem tips); capsules (very rare) immersed; peristome none *Bryoxiphium*, p. 62
9. Leaves inserted in more than 2 rows (though sometimes strongly complanate and thus appearing 2-ranked)
13. Leaves strikingly squarrose-recurved, in 5 distinct rows; cells mammillose on both surfaces *Paludella*, p. 186
13. Leaves erect to wide-spreading, if ± squarrose-recurved, not distinctly 5-ranked; cells variously smooth, bulging, or papillose

14. Peristome of 4 teeth (nearly always evident; sterile plants can be recognized by gemma cups in *Tetraphis* or protonematal flaps which are particularly obvious in *Tetradontium*)
15. Plants rather small, caespitose, nearly always on rotten stumps; sterile plants commonly ending in a gemma cup; costa well developed; upper cells isodiametric; capsules cylindric; operculum not apiculate *Tetraphis*, p. 350
15. Plants minute, scattered or gregarious, on soil in dark recesses, not gemmiferous; costa weak, ending below the apex or even lacking; cells elongate; capsules oblong-ovoid; operculum obliquely apiculate *Tetradontium*, p. 351

14. Peristome of more than 4 teeth, or none
16. Leaves few, small, evanescent (rarely seen); plants consisting mainly of a disproportionately large, strongly inclined, ovoid-ventricose capsule on a stout, rough seta *Buxbaumia*, p. 345

16. Leaves well-developed, persistent; plants not consisting mainly of sporophyte
17. Leaves ligulate, rounded at the tip, with bulging cells in more than 1 layer; perichaetial leaves scarious, bristle-tipped; capsule sessile, inclined, asymmetric, ovoid-ventricose *Diphyscium*, p. 348

17. Leaves and capsules not as above
18. Stems erect, simple or sparsely forked, generally in tufts; archegonia and sporophytes terminal (though sometimes appearing lateral because of innovating branches)
19. Capsules not operculate (rupturing irregularly); plants minute, ephemeral
20. Leaf margins involute *Astomum*, p. 102
20. Leaf margins not involute
21. Capsules emergent to shortly exserted, shortly pyriform because of a stout neck (in outline resembling an observation balloon) *Bruchia*, p. 78
21. Capsules immersed, ± spherical, without a neck
22. Plants bulbiform (sometimes 3-angled); leaves erect-appressed, very broad and deeply concave or concave-keeled *Acaulon*, p. 119
22. Plants not bulbiform or 3-angled; leaves erect to spreading, narrower, plane or slightly concave
23. Leaves setaceous *Pleuridium*, p. 66
23. Leaves narrow to broad but scarcely setaceous
24. Plants from an abundant and conspicuous protonema; leaves linear to lanceolate, acute; margins plane; cells smooth or coarsely unipapillose at the ends *Ephemerum*, p. 139
24. Plants from a scant, inconspicuous protonema; leaves broadly oblong-lanceolate to oblong-obovate, ending in a yellowish, smooth awn; margins revolute; cells pluripapillose *Phascum*, p. 112

19. Capsules operculate; plants mostly not minute or ephemeral
25. Plants minute, ephemeral; capsules immersed
26. Exothecial cells very lax and thin-walled *Physcomitrella*, p. 133
26. Exothecial cells firmer, evenly thickened or thickened at the corners
27. Capsules dehiscing at the middle; exothecial cells conspicuously thickened at the corners *Aphanorrhegma*, p. 133
27. Capsules dehiscing above the middle; exothecial cells not thickened at the corners *Physcomitrium immersum*, p. 133
25. Plants small to large (rarely minute), not ephemeral; capsules mostly exserted
28. Plants on dung (or other organic matter of animal origin); capsules erect and symmetric, with a sterile apophysis broader than the urn and considerably differentiated in size, shape, and color
29. Apophysis much larger than the urn, either globose and wrinkled or expanded and umbrella-like, brightly colored; peristome teeth sometimes in pairs, chambered (as seen in section) *Splachnum*, p. 141
29. Apophysis only somewhat broader than the urn, yellow-brown to dark-red; peristome teeth at first fused in 4's, later 2's, solid *Tetraplodon*, p. 142

28. Plants not on dung; capsules erect and symmetric or inclined and asymmetric, the neck sometimes well developed but not broader than the urn
30. Leaf cells conspicuously bulging or mammillose (at least on the upper surface)
31. Leaf cells mammillose on both surfaces; peristome single, with forked teeth vertically pitted-striolate below *Dichodontium*, p. 90

31. Leaf cells bulging on the upper surface only; peristome none or double, the teeth not forked or vertically pitted-striolate
  32. Leaves broadly lanceolate from a broader base, acute; capsules inclined to pendulous; peristome double, the endostome consisting of 64 long-filiform cilia; calyptra often adhering to the tip of the seta after falling from the mature capsule; brood bodies none *Timmia*, p. 180
  32. Leaves broadly oblong-obovate, obtuse and apiculate; capsules erect; peristome none; calyptra not adhering to the tip of the seta; brood bodies often borne on axillary filaments *Hyophila*, p. 108
30. Leaf cells smooth or papillose
  33. Leaf cells papillose (or rarely longitudinally verruculose-striolate)
    34. Alar cells brownish, quadrate, somewhat enlarged or inflated
      35. Perichaetial leaves truncate or short-pointed; capsules erect and symmetric; peristome teeth inserted below the mouth, undivided; upper cells (in our species) longitudinally striolate *Dicranoweisia*, p. 92
      35. Perichaetial leaves subulate; capsules suberect to inclined, somewhat to distinctly asymmetric; peristome teeth inserted at the mouth, forked; upper cells coarsely and often irregularly papillose at back *Dicranum*, in part, p. 79
    34. Alar cells not noticeably differentiated
      36. Leaf cells longitudinally striolate (*Amphidium mougeotii*, not yet found in Michigan, has ± elongate papillae, rather similar to cuticular striae) *Plagiopus*, p. 191
      36. Leaf cells papillose
        37. Stems repeatedly forked (and sometimes appearing ± pleurocarpous in habit); sporophytes often produced at intervals
          38. Leaves crisped when dry; cells pluripapillose; capsules narrowly urceolate and deeply furrowed when dry *Amphidium lapponicum*, p. 208
          38. Leaves not much contorted when dry; cells with 1, sometimes 2 papillae; capsules ovoid to hemispheric, smooth
            39. Perichaetial leaves conspicuously ciliate at the margins; peristome none; leaves ecostate, nearly always ending in a broad, hyaline awn or at least a short tip; upper cells coarsely 1-2-papillose *Hedwigia*, p. 129
            39. Perichaetial leaves not ciliate; peristome present; leaves costate, muticous to hyaline-tipped or awned, the awn not particularly stout; upper and perichaetial leaves sometimes ± papillose-roughened at back above *Grimmia*, in part, p. 121
        37. Stems simple or sparsely forked, usually not producing sporophytes at intervals
          40. Plants in small, cushion-like tufts on trees and rocks; setae often very short; capsules often immersed; peristome teeth 8 or 16; endostome none or consisting of 8 or 16 cilia
            41. Calyptra cucullate, smooth, naked; capsules long-exserted; leaves long-apiculate; brood bodies common in leaf axils or on radicles *Zygodon*, p. 206
            41. Calyptra mitrate, ± plicate, often hairy; capsules immersed to shortly exserted (rarely rather long-exserted); leaves rarely short-apiculate; brood bodies none or on leaves
              42. Leaves not or slightly contorted when dry; basal cells oblong to linear, moderately thick-walled, not particularly yellow or obliquely arranged, the basal marginal cells not much differentiated; capsules generally immersed; stomata superficial or immersed *Orthotrichum*, p. 195
              42. Leaves often crisped when dry; basal cells linear, very thick-walled, yellow, arranged in rows fanning out from the costa; basal marginal cells short and pale; capsules exserted; stomata superficial *Ulota*, p. 203
          40. Plants generally in more extensive tufts, nearly always on soil or rock; setae generally elongate and capsules distinctly exserted; peristome teeth, if present, 16; endostome none or variously developed but not cilia-like
            43. Leaves narrowed from a clasping base to a squarrose, rough, linear subula *Trichodon*, p. 74
            43. Leaves not as above

44. Leaves broad in proportion to their length, oblong, elliptic, or spatulate (not broadest at the base)
45. Cells of leaf base lax and thin-walled with thickened, red-brown cross walls; calyptra longer than the capsule, narrowly mitrate, falling with the operculum; peristome none, single, or double, the teeth (if present) erect and undivided *Encalypta,* p. 94
45. Cells of leaf base lax and thin-walled, without thickened cross walls; calyptra shorter than the capsule, cucullate, falling before the operculum; peristome usually present, single, consisting of 32 filiform divisions ± wound together in a spiral
46. Cells of leaf base nearly always abruptly differentiated in well-marked hyaline groups; leaf margins rarely differentiated; peristome teeth long-filiform and closely wound together above a high basal tube *Tortula,* p. 116
46. Cells of leaf base less conspicuously differentiated; cells at leaf margins usually with thicker, yellowish walls, forming a ± evident border; peristome (if present) shorter, oblique or loosely spiraled above a low basal membrane *Desmatodon,* p. 115

44. Leaves considerably longer than broad, lanceolate, linear-lanceolate or subulate (broadest near the base)
47. Leaf margins involute *Weissia,* p. 100
47. Leaf margins not involute
48. Sterile stems often ending in a stalk bearing brood bodies at its tip; costa often flexuose above; cells isodiametric, centrally papillose *Aulacomnium,* in part, p. 181
48. Sterile stems not ending in a gemmiferous stalk; costa straight; cells isodiametric and indistinctly papillose over the lumina or elongate and papillose at 1 or both ends
49. Leaf cells papillose at 1 or both ends; capsules strongly inclined, broadly ovoid, asymmetric, and ribbed, becoming deeply furrowed, contracted at the middle, and ventricose-bulging at the base when dry; peristome double
50. Plants of seepy places; leaves lanceolate, not sheathing at base; cells translucent, papillose at 1 or both ends *Philonotis,* p. 193
50. Plants of dryer habitats (especially on soil of banks or in crevices of cliffs); leaves linear-subulate from a broad, somewhat to strongly sheathing base; cells obscure, papillose at both ends (see also *Plagiopus* which has verruculose-striolate cells) *Bartramia,* p. 191

49. Leaf cells not papillose at the ends; capsules mostly erect, narrower and otherwise not as above; peristome none or single
51. Leaf cells with 1 low, broad, often indistinct papilla over each lumen
52. Capsules suberect to inclined, asymmetric, furrowed, sometimes strumose; peristome teeth deeply divided into flat forks, vertically pitted-striate *Cynodontium,* p. 91
52. Capsules erect, symmetric, smooth, not strumose; peristome teeth split nearly to the base into 32 terete, papillose divisions
53. Peristome consisting of filiform divisions spirally wound together *Barbula,* in part, p. 108
53. Peristome consisting of slender but scarcely filiform, erect divisions *Didymodon,* p. 106

51. Leaf cells pluripapillose
54. Leaf margins revolute on 1 or both sides
55. Leaf margins revolute on 1 side below; capsules systylious (the operculum remaining attached to the columella for a time after dehiscence); peristome none *Gymnostomum recurvirostrum,* p. 99
55. Leaf margins revolute on both sides; capsules not systylious; peristome none or well developed
56. Plants very small, scattered, ephemeral, on soil in disturbed places; leaves ending in a red apiculus or

short awn; peristome none; calyptra finely papillose throughout *Pottia*, in part, p. 112

56. Plants small to fairly robust, ± tufted, not ephemeral; leaves muticous or hyaline-apiculate; peristome present; calyptra smooth
57. Plants not reddish below; leaves entire; basal cells firm-walled; peristome consisting of 32 long-filiform divisions wound together in a spiral *Barbula*, in part, p. 108
57. Plants brick-red below; leaves irregularly dentate near the apex; basal cells lax and thin-walled; peristome consisting of 32 shorter, erect or ± oblique divisions *Bryoerythrophyllum*, p. 105

54. Leaf margins plane or erect
58. Cells of leaf base large, lax, and hyaline, noticeably extending beyond the shoulders as a V-shaped border *Tortella*, p. 102
58. Cells of leaf base not extending up the margins above the shoulders (or only slightly so)
59. Leaves abruptly and irregularly toothed at junction of hyaline basal cells and green upper cells *Eucladium*, p. 100
59. Leaves entire or slightly and remotely sinuate-notched above
60. Plants of moderate size; leaves concave, ± tapered, acute and apiculate; margins erect, ± notched and sinuose; basal cells lax and thin-walled; peristome teeth filiform, twisted in a loose spiral *Trichostomum*, p. 105
60. Plants small; leaves somewhat keeled or nearly flat, scarcely tapered (with ± parallel sides), bluntly acute; margins plane, entire; basal cells firm; peristome none or greatly reduced
61. Annulus present; peristome reduced to mere fragments *Gyroweisia*, p. 99
61. Annulus and peristome none *Gymnostomum aeruginosum*, p. 98

33. Leaf cells smooth
62. Plants in dark, green, brown, or blackish, often hoary tufts on rock; leaves generally awned; cells often with sinuose-thickened walls; peristome single, consisting of 8 teeth (or rarely none) *Grimmia*, p. 121
62. Plants not blackish or hoary, on various substrates; leaves not awned; cell walls not sinuous-thickened; peristome lacking, single, or double, if present, the teeth 16
63. Plants minute, on limestone; peristome usually present, single, with teeth undivided *Seligeria*, p. 63
63. Plants small to robust, on various substrates; peristome various, if single, the teeth ± divided
64. Capsules cylindric, erect or ± curved from a long, narrow, erect neck 1-2 times as long as the urn *Trematodon*, p. 78
64. Capsules not long-necked
65. Leaves proportionately long (more than 5:1)
66. Alar cells differentiated in brown groups
67. Capsules erect and symmetric, pyriform, smooth; peristome teeth undivided or split only at the tips, smooth; plants on wet rocks at edge of brooks *Blindia*, p. 65
67. Capsules mostly inclined, cylindric, ± asymmetric, somewhat furrowed; peristome teeth forked, pitted-striolate; plants of dry or moist habitats (not on wet rocks) *Dicranum*, p. 79
66. Alar cells not particularly differentiated
68. Leaves ± narrowed from a broad, erect or sheathing base; capsules strumose at base
69. Leaves contorted when dry; autoicous plants of woodland habitats *Oncophorus*, p. 78
69. Leaves not or slightly contorted when dry; dioicous plants of ± wet, disturbed soil *Dicranella*, in part, p. 74
68. Leaves more gradually tapered, not particularly sheathing at base; capsules not distinctly strumose

70. Leaf cells long-rhomboidal to linear (ca. 6-12:1); capsules inclined, pyriform or oblong-pyriform; peristome double
 71. Leaves linear-subulate; costa filling about ½ the base and most of the subula *Leptobryum*, p. 149
 71. Leaves oblong-lanceolate; costa narrow *Pohlia*, in part, p. 151
70. Leaf cells shorter; capsules erect or inclined, not pyriform; peristome single or none
 72. Capsules minute, horizontal, black, smooth, shiny; peristome none; plants in very compact tufts in wet, calcareous fen habitats *Catoscopium*, p. 189
 72. Capsules not as above; peristome single; plants in loose or dense tufts, in moist or rarely wet habitats
  73. Leaves ligulate, rounded-obtuse; peristome teeth not forked; plants on granitic rock *Rhabdoweisia*, p. 90
  73. Leaves tapered from the base, linear to ovate-lanceolate, acute; peristome deeply cleft or perforate; plants on soil (or a variety of habitats in disturbed places)
   74. Peristome teeth flat, split ½ way down, mostly vertically pitted-striolate *Dicranella*, in part, p. 74
   74. Peristome teeth irregularly perforate or deeply cleft into terete, sometimes filiform divisions
    75. Leaves narrowly lanceolate to subulate; margins neither revolute throughout nor toothed near the apex *Ditrichum*, p. 71
    75. Leaves lanceolate or ovate-lanceolate; margins revolute nearly throughout and irregularly toothed near the apex
     76. Plants bluish or glaucous; autoicous; perichaetial leaves not broadly pointed or sheathing; setae yellow-brown; capsules erect, symmetric, wrinkled-striate when dry, pale-brownish; peristome teeth bifid nearly to the base, not thickened or connected at the nodes *Saelania*, p. 71
     76. Plants dark-green to red-brown; dioicous; perichaetial leaves broadly pointed, strongly sheathing; setae red; capsules strongly inclined and asymmetric, furrowed, dark purplish-red or red-brown; peristome teeth bifid nearly to the base but thickened and joined by cross-connections at the nodes below *Ceratodon*, p. 69
65. Leaves proportionately broad (less than 5:1)
 77. Upper cells linear or long-rhomboidal (ca. 5-12:1)
  78. Sporophytes from a short basal shoot overtopped by a long innovation; peristome delicate and single (consisting of endostome); plants on copper-bearing rock *Mielichhoferia*, p. 165
  78. Sporophytes terminal; peristome double, well developed; plants of various substrates, not associated with copper *Pohlia*, in part, p. 151
 77. Upper cells shorter, isodiametric to short-rhomboidal
  79. Leaves bordered by narrow or linear cells
   80. Leaf cells rhomboidal
    81. Stems connected by creeping, underground "rhizomes"; leaves in dense terminal rosettes *Rhodobryum*, p. 164
    81. Stems not connected by underground rhizomes; leaves not in conspicuous rosettes (though sometimes larger and more crowded toward the stem tips) *Bryum*, p. 156
   80. Leaf cells isodiametric, ± hexagonal, rarely somewhat elongate
    82. Capsules erect, cylindric; peristome single, consisting of 32 short teeth attached at their tips to a broad membrane nearly closing the capsule; costa bearing a few short, often obsolete, ventral lamellae *Atrichum crispum*, p. 355
    82. Capsules nodding, broadly oblong-cylindric; peristome double, with 16 teeth, not attached to a central membrane; costa not lamellose
     83. Leaves entire or toothed and singly or doubly serrate; endostome no longer than the exostome, consisting of free, keeled and perforate segments and cilia from a high basal membrane *Mnium*, p. 166

83. Leaves entire; endostome longer than the exostome, consisting of a dome supported on narrow, flat segments *Cinclidium,* p. 178

79. Leaves not bordered by narrow or linear cells
84. Leaf cells isodiametric
85. Leaves deeply concave, broadly oblong-ovate, unbordered, strongly serrate; capsules curved and inclined, strongly ribbed *Aulacomnium heterostichum,* p. 182
85. Leaves not particularly concave, variously elliptic to obovate, if strongly serrate, distinctly bordered; capsules erect to inclined but not ribbed
86. Plants on copper-bearing rock; leaves oblong-spatulate, rounded at the apex; marginal cells somewhat thicker-walled than the inner, often forming a distinct border *Scopelophila,* p. 119
86. Plants not as above
87. Plants very small; capsules erect, minute, obovoid, becoming wide-mouthed when dry and empty; peristome none (or very rudimentary) *Pottia truncata,* p. 113
87. Plants larger; capsules erect to nodding, cylindric to oblong-cylindric; peristome well developed
88. Leaves mucronate or awned, entire and revolute at the margins; costa excurrent; capsules erect and symmetric, narrowly cylindric; peristome single, consisting of 32 long threads spirally twisted together above a basal tube *Tortula mucronifolia,* p. 116
88. Leaves broadly acute, plane and remotely and irregularly toothed at the margins; costa ending below the apex; peristome double, not twisted *Mnium stellare,* p. 167
84. Leaf cells somewhat elongate and rectangular to short-rhomboidal
89. Plants julaceous, silvery-green; upper cells not particularly large, short-rhomboidal, lax, hyaline; lower cells subquadrate, green *Bryum argenteum,* p. 159
89. Plants not julaceous, green or yellow; upper cells large and pellucid, variously oblong, oblong-hexagonal or short-rhomboidal, not paler or laxer than lower cells
90. Capsules erect or strongly inclined from the base, the neck broad and much shorter than the urn; peristome none, single, or double (with the endostome reduced)
91. Capsules erect and symmetric; peristome none *Physcomitrium,* p. 131
91. Capsules inclined to horizontal, asymmetric; peristome double *Funaria,* p. 134
90. Capsules curved and inclined from a long, tapered, erect neck; peristome double (the endostome delicate and irregularly developed but longer than the exostome)
92. Plants soft and delicate; leaves erect, shrunken when dry, oblong-lanceolate, rather abruptly narrowed to a short, sharp point; cells lax, thin-walled; perichaetial leaves not differentiated *Amblyodon,* p. 186
92. Plants coarse, more rigid; leaves erect or wide-spreading in 3 rows, not shrunken when dry, oblong-lanceolate to ligulate, rounded-obtuse or acute; cells firm; perichaetial leaves elongate *Meesia,* p. 186

18. Stems creeping or ascending, freely branched, usually in interwoven mats; archegonia and sporophytes lateral (or at the ends of branches)
93. Leaf cells with nodulose-wavy walls; peristome teeth split nearly to the base into 2-3 filiform divisions *Rhacomitrium,* p. 126
93. Leaf cells not nodulose; peristome teeth (if present) split to the base into filiform divisions
94. Leaf cells papillose
95. Leaf cells papillose at back because of projecting upper angles
96. Stem and branch leaves obviously differentiated in size and shape

97. Plants 1-pinnate; paraphyllia very few and polymorphous; upper leaf cells hexagonal to short-rhombic *Heterocladium,* p. 230
97. Plants 2-3-pinnate in flat, layered fronds; paraphyllia felting stems and branches, filiform-branched; upper cells linear-rhomboidal *Hylocomium splendens,* p. 342

96. Stem and branch leaves not conspicuously differentiated
98. Branches smoothly julaceous wet or dry; leaves crowded, tightly appressed, rounded-ovate, rounded and sometimes apiculate at the apex *Myurella julacea,* p. 229
98. Branches not particularly julaceous; leaves not notably crowded or appressed, ± acute
99. Costa single, extending beyond the leaf middle
100. Leaves secund, 3-5 mm. long, both rugose and plicate *Rhytidium,* p. 345
100. Leaves not or slightly secund, up to 1.2 mm. long, not rugose, sometimes ± biplicate
101. Plants on soil; leaves (especially on stems) noticeably decurrent, with sharply serrate, plane margins; costa not prominent at back; cells not particularly opaque, oblong to linear-rhomboidal; paraphyllia none *Bryhnia,* p. 292
101. Plants on rock; leaves decurrent, with entire or ± serrulate, usually revolute margins; costa prominent; cells opaque, isodiametric to short-oblong; paraphyllia present, few to moderately numerous *Pseudoleskea,* p. 226

99. Costa double and usually very short, or none
102. Plants robust, coarse, erect; leaves wide-spreading, cordate-triangular; costae extending ½ or more the leaf length; upper cells irregularly spinose at back *Rhytidiadelphus triquetrus,* p. 340
102. Plants smaller, creeping; leaves erect or secund, oblong-elliptic and short-pointed or abruptly acuminate from a broad base; costa short and double or none; upper cells with small, scarcely spinose papillae
103. Plants of medium size, pinnately branched in a triangular frond; leaves falcate-secund, abruptly acuminate from a cordate, decurrent base *Ctenidium,* p. 332
103. Plants small and slender, sparsely and irregularly branched; leaves oblong-elliptic, broadly acute, not decurrent *Pterigynandrum,* p. 229

95. Leaf cells with 1 or more papillae over each lumen
104. Costa very short and double or none
105. Leaves erect-spreading, moderately concave, ovate-lanceolate, acuminate, serrulate all around; papillae small and indistinct *Schwetschkeopsis,* p. 223
105. Leaves rounded or rounded-ovate, deeply concave, abruptly apiculate to short-acuminate; papillae distinct *Myurella sibirica,* p. 229
104. Costa single, ending at or above the middle
106. Branches julaceous; leaves rounded, deeply concave; cells with a single, large, simple and curved or intricately branched papilla *Thelia,* p. 236
106. Branches often terete but not julaceous; leaves ovate or lanceolate, moderately concave; cells with 1-several, not intricately branched papillae
107. Leaves ending in a short, yellowish or hyaline hairpoint
108. Plants typically occurring as scattered strands on trunks of trees (rarely on other substrates); leaves squarrose when moist, abruptly narrowed to a short, yellowish hairpoint; cells rather coarsely unipapillose *Lindbergia,* p. 238
108. Plants in dense mats on rock or bases of trees; leaves not squarrose when moist, gradually narrowed to a hyaline hairpoint; cells pluripapillose *Anomodon rostratus,* p. 233

107. Leaves not ending in a hairpoint
109. Plants irregularly branched; paraphyllia none or few and lanceolate
110. Leaf cells distinctly pluripapillose
111. Leaves usually broken off near the middle *Haplohymenium,* p. 236
111. Leaves not broken *Anomodon,* p. 232
110. Leaf cells unipapillose (the papillae often broad, blunt, and indistinct)
112. Paraphyllia none or few; leaves broadly lanceolate or ovate, obtuse or bluntly and often obliquely pointed; margins plane;

cells isodiametric, rather indistinctly papillose; capsules erect or ± curved, cylindric; plants on trees *Leskea,* p. 225

112. Paraphyllia few to fairly numerous; leaves lanceolate, acuminate, not obliquely pointed; margins usually revolute; cells isodiametric or somewhat elongate, papillose centrally or somewhat nearer the upper ends (sometimes indistinctly papillose, or smooth); capsules inclined and asymmetric, oblong-cylindric, ± tapered at base; plants on rock *Pseudoleskea,* p. 226

109. Plants 1-2-pinnately branched, usually evenly so and frondose; paraphyllia numerous, in most cases felting stems and branches, short and linear or longer, filiform, and ± branched

113. Paraphyllia filiform-branched, matted on stems, less abundant on branches, also attached to leaf bases; plants loosely 1-pinnate (sometimes unequally so); cells somewhat elongate; papillae single, central or near the upper end *Helodium,* p. 247

113. Paraphyllia shorter, abundant but not matted or noticeably attached to leaf bases; plants 1-3-pinnate, usually evenly so, sometimes frondose; papillae single and ± central or many

114. Plants evenly 1-3-pinnate, often frondose; apical cells of branch leaves truncate and pluripapillose; cells uni- or pluripapillose *Thuidium,* p. 240

114. Plants loosely subpinnate, not frondose; apical cells of branch leaves not truncate, ending in a single papilla; cells unipapillose *Haplocladium,* p. 239

94. Leaf cells smooth (see also *Myurella julacea*)

115. Paraphyllia abundant

116. Plants dendroid, connected by a creeping, underground "rhizome" *Climacium,* p. 336

116. Plants not dendroid or rhizomatous

117. Plants of calcareous seeps; leaves somewhat to strongly falcate-secund; costa single, strong, ending well above the midleaf or even excurrent; paraphyllia very few to numerous, unbranched *Cratoneuron,* p. 250

117. Plants of moist or wet woodlands, not in seepage; costa single or double, more slender and ending far below the leaf apex; paraphyllia abundant, filiform-branched *Hylocomium,* in part, p. 342

115. Paraphyllia few or none

118. Plants submerged at flood time, otherwise stranded; leaves long, narrow, setaceous, strongly falcate-secund, keeled, 3-ranked *Dichelyma,* p. 216

118. Plants of varying habitats (some submerged or emergent, but not normally stranded, except in some species of *Fontinalis*); leaves neither keeled nor 3-ranked (or if so, not falcate-secund)

119. Costa typically single (though ± variable in *Forsstroemia, Homalia, Pseudoleskeella,* and *Hygrohypnum*), extending to the leaf middle or beyond

120. Plants normally submerged

121. Leaves ± falcate-secund; stems and branches hooked at the tips *Drepanocladus,* p. 263

121. Leaves not falcate-secund; stem and branch tips not hooked

122. Leaves wide-spreading and loosely complanate *Leptodictyum riparium,* p. 256

122. Leaves erect or spreading

123. Leaves lanceolate, acute or acuminate; upper cells firm- or thick-walled, shortly rhomboidal (ca. 2-6:1); costa stout, subpercurrent to excurrent *Hygroamblystegium,* p. 258

123. Leaves broader, broadly pointed or rounded at the apex; cells thin- or firm-walled, long-rhomboidal; costa relatively strong but not percurrent or excurrent

124. Leaves rounded-ovate, acute or obtuse, serrulate all around; apical cells short and rhombic, noticeably shorter than the upper median; alar cells scarcely differentiated *Eurhynchium riparioides,* p. 298

124. Leaves cordate-ovate, broadly rounded at the apex, entire; apical cells not differentiated; alar cells large, lax, hyaline *Calliergon,* in part, p. 271

120. Plants in dry to wet habitats, not normally submerged
125. Plants on tree trunks; stems long, creeping; branches crowded, erect, bearing sporophytes at their tips; leaf cells rounded-quadrate and green throughout; peristome single, of 16 very short, truncate teeth *Drummondia,* p. 207
125. Plants on various substrates; stems variously creeping to erect-ascending, with branches horizontal to ascending; sporophytes on lateral buds, not at tips of well-formed branches; upper cells shortly rhomboidal to linear; peristome double
126. Plants of seepy, calcareous habitats (usually emergent from shallow water); stems erect-ascending, subpinnately branched, ending in a long, unbranched tip curved at the apex; costa strong; cells short; alar cells inflated in well-marked groups *Cratoneuron filicinum,* p. 250
126. Plants of dry or wet habitats but not in seepage; stems ± prostrate or crowded and ascending, freely branched but not pinnate below a long, finger-like extension of the stem; costa various; upper cells elongate; alar cells scarcely differentiated to inflated in well-marked groups
127. Branches stoutly and softly julaceous; leaves broad and very concave, abruptly contracted to a slender subula (see also *Bryoandersonia,* not yet found in Michigan) *Cirriphyllum,* p. 294
127. Branches not julaceous; leaves only moderately concave, not abruptly subulate
128. Leaves long-lanceolate, slenderly acuminate, falcate-secund *Drepanocladus,* p. 263
128. Leaves ovate or lanceolate, not or rarely subsecund (or if long-lanceolate and falcate secund, tomentose, with plicate leaves)
129. Upper cells short (up to 5:1)
130. Leaves serrulate above the middle; setae rough *Brachythecium reflexum,* p. 284
130. Leaves entire or slightly denticulate either below or at the apex
131. Leaves wide-spreading from the insertion *Leptodictyum,* in part, p. 256
131. Leaves erect or appressed
132. Plants commonly bearing dense clusters of bud-like brood branches in leaf axils
133. Costa nearly filling the slender acumen and usually excurrent; peristome teeth smooth *Leskeella,* p. 226
133. Costa variable, usually single and ending at or below the midleaf, sometimes longer, sometimes nearly lacking; peristome teeth cross-striolate *Pseudoleskeella,* p. 227
132. Plants without brood branches
134. Costa variable in length, sometimes double or nearly lacking
135. Plants growing on trunks of trees, erect and loosely subpinnate from a wiry, creeping primary stem; perichaetia large, sheathing; capsules immersed to shortly exserted *Forsstroemia,* p. 208
135. Plants on rock, irregularly branched; perichaetia not greatly enlarged; capsules exserted *Pseudoleskeella,* p. 227
134. Costa single, not particularly variable
136. Plants growing in knotholes and other protected crevices of bark; capsules erect and symmetric, greatly constricted below the mouth when dry; peristome teeth recurved when dry *Anacamptodon,* p. 222
136. Plants not on trees; capsules horizontally inclined, curved and asymmetric, less conspicuously constricted below the mouth; peristome teeth incurved when dry
137. Costa stout, percurrent to excurrent; plants relatively coarse, sometimes robust, growing on wet rocks in or beside brooks *Hygroamblystegium,* p. 258

137. Costa slender, ending at or below the leaf middle or sometimes in the acumen; plants small and slender, in swampy habitats *Amblystegium*, p. 261

129. Upper cells longer

138. Leaves conspicuously complanate (and appearing to be 2-ranked), broadly elliptic, rounded and often apiculate at the apex, ± asymmetric *Homalia*, p. 220

138. Leaves not or loosely complanate (not appearing 2-ranked), lanceolate to cordate-ovate, rounded at the apex to acute or acuminate

139. Leaves loosely and often indistinctly complanate, acute or acuminate

140. Plants of swampy habitats, particularly in places subject to flooding; leaves entire, not twisted at the tips; costa not projecting as a tip at back *Leptodictyum*, p. 256

140. Plants of various woodland habitats; leaves serrulate to serrate, often twisted at the tips; costa usually projecting as a tooth at back

141. Leaves oblong-lanceolate; alar cells somewhat differentiated in small groups; seta rough; operculum conic, acute *Brachythecium curtum*, p. 290

141. Leaves oblong-ovate; alar cells scarcely differentiated; seta smooth; operculum obliquely long-rostrate *Rhynchostegium*, p. 299

139. Leaves not at all complanate, rounded to acuminate at the apex

142. Alar cells considerably differentiated, larger and laxer or conspicuously hyaline and inflated

143. Leaves elliptic to suborbicular, broadly rounded (and sometimes apiculate) at the apex *Calliergon*, in part, p. 271

143. Leaves ovate to lanceolate, acuminate to a narrow, sharp or blunt tip

144. Plants freely branched and often ± dendroid in dense, tufted mats; stem leaves broadly decurrent with alar cells relatively large; leaves sharply pointed *Brachythecium rivulare*, p. 291

144. Plants loosely branched, in loose masses; leaves with ± inflated alar cells, sometimes auriculate but not broadly decurrent as above; leaves acuminate to a narrow, rounded or blunt tip *Calliergidium*, p. 267, 273

142. Alar cells not much differentiated

145. Leaves rounded at the apex

146. Costa relatively strong and single or double on the same plants; plants growing on wet rocks in or beside streams *Hygrohypnum*, in part, p. 270

146. Costa generally single; plants of wet, sedgey, calcareous fens *Calliergon trifarium*, p. 273

145. Leaves acute or acuminate

147. Leaves broadly oblong-ovate to orbicular, concave and usually cucullate at the apex; costa single or double, often on the same plants, usually fairly well developed *Hygrohypnum*, in part, p. 270

147. Leaves, narrower, less conspicuously concave, not cucullate at the apex

148. Leaves wide-spreading to ± squarrose-recurved or subsecund *Campylium*, in part, p. 251

148. Leaves erect or erect-spreading

149. Plants erect, usually in dense tufts, brown-tomentose with numerous wide-spreading branches below, unbranched above; leaves conspicuously plicate *Tomenthypnum*, p. 281

149. Plants creeping or ascending, not tomentose, freely and irregularly branched; leaves smooth or somewhat plicate

150. Plants very slender, in wet habitats; leaves not plicate, abruptly toothed near the base; brood bodies often borne at back of costa near the leaf tip
*Rhynchostegiella,* p. 300
150. Plants more robust, small to large, in wet or rather dry habitats; leaves mostly ± plicate, variously entire or serrulate but not abruptly toothed at base; brood bodies none
151. Leaves acute or obtuse; apical cells obviously shorter than the median; operculum long-rostrate
*Eurhynchium,* p. 296
151. Leaves acuminate; apical cells similar to the median; operculum merely apiculate *Brachythecium,* p. 283
119. Costa short and double or none
152. Plants often very long, trailing from a point of attachment, submerged in flowing water (or rarely stranded except at flood time)
*Fontinalis,* p. 213
152. Plants not submerged (or otherwise as above)
153. Leaf cells less than 6:1
154. Leaf cells squarrose-recurved from a suberect, ± clasping base
*Campylium hispidulum,* p. 251
154. Leaves not squarrose
155. Leaves plicate; cells thick-walled; capsules immersed; perichaetial leaves long-sheathing; plants coarse, relatively robust *Leucodon,* p. 211
155. Leaves not plicate; cells thin-walled; capsules exserted; perichaetial leaves not particularly elongate or sheathing; plants small or minute
156. Plants minute; leaves coarsely dentate; cells rhombic; exothecial cells with wavy walls; peristome single *Fabronia,* p. 223
156. Plants minute or small; leaves entire or nearly so; cells rhombic or shortly oblong-rhomboidal; exothecial cells straight-walled; peristome double
157. Leaves only 0.15-0.5 mm. long, ± flat; alar cells scarcely differentiated or subquadrate in small and inconspicuous groups *Platydictya,* p. 319
157. Leaves 0.5-0.8 mm. long, concave; alar cells subquadrate in triangular groups extending 1/3 up the margins *Homomallium,* p. 318
153. Leaf cells longer
158. Plants invariably producing dense, axillary clusters of bud-like brood branches (especially noticeable at branch tips)
*Platygyrium,* p. 315
158. Plants without brood bodies
159. Leaves distinctly complanate
160. Leaves conspicuously undulate; plants on trunks of trees (rarely on rock) *Neckera,* p. 219
160. Leaves not undulate; plants on various substrates but not on trunks of trees
161. Leaves very shiny, golden-green, falcate and serrate at the tips; alar cells inflated in a group of 3-4 across the insertion and 3-4 up the margins *Brotherella,* p. 313
161. Leaves ± shiny but not golden, neither falcate nor serrate at the tips; alar cells not inflated
162. Leaves decurrent *Plagiothecium,* in part, p. 307
162. Leaves not decurrent
163. Leaves broadly oblong-ovate, erect-spreading, entire; alar cells loosely quadrate; capsules erect and symmetric; peristome teeth smooth, papillose, or variously striolate; endostome with a very low basal membrane, linear segments, and no cilia *Entodon,* in part, p. 304
163. Leaves lanceolate, wide-spreading, mostly ± serrulate; alar cells scarcely differentiated; capsules mostly inclined and asymmetric; peristome perfect and "hypnaceous"
164. Leaves rigidly distichous-complanate and pectinate in appearance; cortical cells large, thin-walled; leaves entire; alar

cells scarcely differentiated; capsules ± erect and symmetric *Isopterygiopsis*, p. 323

164. Leaves not or ± complanate, not rigid or pectinate; cortical cells not much differentiated; leaves mostly ± serrulate; alar cells often ± differentiated; capsules inclined and asymmetric

165. Leaves serrulate all around; apical cells shorter than the median *Taxiphyllum*, p. 323

165. Leaves entire or serrulate only near the apex; apical cells not differentiated *Isopterygium*, p. 322

159. Leaves not at all or only loosely and indistinctly complanate

166. Alar cells inflated

167. Leaves broadly rounded and usually apiculate at the apex; alar cells in large and conspicuous auricles *Calliergonella*, p. 277

167. Leaves acute or acuminate; alar cells in ± conspicuous decurrencies

168. Branches terete-foliate or loosely and irregularly complanate-foliate (sometimes on the same plants); margins ± revolute, entire or sometimes serrulate at the extreme tip; alar cells somewhat inflated in narrow decurrencies *Plagiothecium cavifolium*, p. 307

168. Branches not terete; leaves wide-spreading or squarrose (and occasionally somewhat complanate); margins plane, serrulate in the upper ½ or more; alar cells lax and inflated in conspicuous hyaline to red-yellow decurrencies *Herzogiella striatella*, p. 332

166. Alar cells not inflated, though sometimes ± enlarged or otherwise differentiated

169. Leaves wide-spreading to squarrose, not at all complanate or secund

170. Plants of open fens; leaves longitudinally striolate when dry; alar cells enlarged *Campylium stellatum*, p. 254

170. Plants of moist woodlands or open grassy places but not fens; leaves smooth or plicate, not striolate; alar cells not or somewhat differentiated *Rhytidiadelphus*, in part, p. 340

169. Leaves not wide-spreading to squarrose, sometimes ± complanate or secund

171. Leaves falcate-secund

172. Cortical cells of stems and branches large and hyaline (stripping off with leaves on dissection); alar cells large, lax, hyaline

173. Plants on wet rocks in or near streams; leaves not complanate, acuminate to a narrow but blunt or rounded tip, the acumen twisted-flexuose when dry; costa ½ or more the leaf length, double or forked, rarely single *Hygrohypnum ochraceum*, p. 271

173. Plants on various substrates in moist or swampy habitats but not normally on rock in stream beds; leaves sometimes plainly complanate, acuminate to an acute point, the acumen not twisted; costa short and double *Hypnum*, in part, p. 324

172. Cortical cells not large and hyaline; alar cells various

174. Plants robust and tumid or stoutly julaceous, floating or emergent from the shallow water of calcareous fens; leaves striolate and ± undulate when dry *Scorpidium scorpioides*, p. 278

174. Plants of moderate size, more slenderly julaceous, if at all, not floating or emergent, not growing in fen habitats

175. Plants irregularly branched, on wet rocks in or near brooks; leaves broad, cucullate at the broad apex; costa variable and single or double, often well developed *Hygrohypnum*, in part, p. 270

175. Plants usually pinnately branched, in moist woodland habitats; leaves lanceolate or ovate and acuminate, not cucullate at the apex; costa short and double or none

176. Plants very regularly pinnate and frondose; leaves strongly plicate *Ptilium,* p. 334
176. Plants irregularly to regularly pinnate; leaves only rarely ± plicate *Hypnum,* p. 324

171. Leaves not falcate-secund (though sometimes ± homomallous, especially when dry)
177. Plants stoutly julaceous, emergent from shallow water of calcareous fens; leaves rounded and ± apiculate and not cucullate at the apex *Scorpidium turgescens,* p. 280
177. Plants more slenderly julaceous, if at all, not emergent and not found in fens; leaves narrowly or broadly pointed, sometimes ± cucullate
178. Alar cells abruptly inflated and usually yellow in a conspicuous row of 3-4 cells at the insertion (rarely 2 rows); exothecial cells with thickened corners *Sematophyllum,* p. 313
178. Alar and exothecial cells not as above
179. Plants on wet rocks in or near streams; leaves broadly pointed to rounded at the apex, concave and often cucullate; costa single or double and variable in length but usually well developed and ¼-¾ the leaf length *Hygrohypnum,* in part, p. 270
179. Plants of drier habitats; leaves acute to acuminate, scarcely to distinctly concave; costae very short and double or lacking
180. Plants on tree trunks; leaves homomallous when dry; branches short, equal, crowded and conspicuously curved in the same direction when dry; alar cells small and quadrate in triangular groups *Pylaisiella,* p. 316
180. Plants not on tree trunks; leaves not homomallous or sometimes ± secund at the tips; branches not particularly short, equal, crowded, or curved; alar cells not as above
181. Leaves oblong-lanceolate, loosely complanate, often ± secund at the tips; margins serrulate in the upper 1/2-2/3; alar cells scarcely differentiated *Herzogiella turfacea,* p. 332
181. Leaves broader, not at all to distinctly complanate; margins entire or somewhat serrulate near the apex; alar cells differentiated
182. Plants ± erect, subpinnate; stems orange; branches julaceous, not at all flattened; alar cells shortly oblong with thick, orange walls *Pleurozium,* p. 301
182. Plants creeping, irregularly branched; branches ± terete or julaceous and slightly flattened; alar cells subquadrate
183. Capsules erect and symmetric, cylindric; peristome double but not hypnaceous, the teeth not cross-striolate); branches julaceous, blunt; leaves ± asymmetric, elliptic, abruptly acute to apiculate *Entodon,* in part, p. 304
183. Capsules suberect, ± curved and asymmetric, oblong-cylindric; peristome hypnaceous, the teeth cross-striolate (soon becoming broken); branches terete, tapered; leaves symmetric, lanceolate, gradually acuminate *Heterophyllium,* p. 310

## SYSTEMATIC ACCOUNT

### Class SPHAGNOPSIDA

A small class consisting of a single genus.

### **Sphagnum** L.

Robust mosses developing from a thallose protonema, growing in wet habitats (usually in peat bogs), often forming large, deep hummocks because of continued apical growth; rhizoids lacking after the initial growth stages. Stems erect, sparsely forked, consisting of a central, thin-walled parenchyma enveloped by a pigmented wood cylinder of thick-walled prosenchyma which is usually surrounded by 1 or more layers of hyaline, thin-walled, parenchymatous cortical cells. Branches usually in fascicles spirally disposed around the stem, crowded at the stem tips in a head-like tuft (the capitulum). Branch leaves spirally arranged, composed of linear, green cells in a network enclosing large, empty, rhomboidal, hyaline cells nearly always with large, rounded or elliptic pores (often bordered by a fibril ring) on both surfaces and nearly always reinforced within by annular or spiral fibrils. Stem leaves less crowded than branch leaves and usually clearly differentiated in size and shape, with a lesser development of pores and fibrils, often showing extensive resorption of the walls of the hyaline cells. Dioicous or monoicous; antheridia and archegonia always on separate branches; paraphyses none; antheridial branches single or in fascicles of 2-3, scarcely differentiated except that the leaves associated with antheridia may be highly colored; antheridia globose or oval, long-stalked, each borne singly at the side of a leaf; archegonial branches single or rarely paired, bearing 1-5 archegonia at the apex; perichaetial leaves much larger and otherwise conspicuously differentiated, enclosing the sporophyte until maturity. Sporophytes consisting of capsule and foot, elevated beyond the perichaetial leaves at maturity by the elongation of the tip of the fruiting branch as a "pseudopodium" (derived from the receptacle); capsules globose (but urceolate to oblong-cylindric when dry and empty), dark-brown or black, operculate, without annulus or peristome, usually with numerous pseudostomata in the lower half or nearly throughout; endothecium giving rise only to the columella which is overarched by the spore cavity. Spores tetrahedral, relatively large (18-42 $\mu$), explosively discharged from the capsule. Calyptra a delicate, hyaline membrane investing the capsule until maturity and finally irregularly ruptured. The name comes from a Greek designation for some plant now indeterminable. *Sphagnum* is commonly known as PEAT MOSS, less often as BOG MOSS.

The genus has a reputation for being very difficult and has been shunned even by professional bryologists seemingly in agreement with W. J. Hooker, who said (in Smith's *English Flora* in 1844), "Linnaeus was perhaps correct in supposing that there was but one species of *Sphagnum*. . . . It is very certain that the limits of the species, if such they may be called, cannot be defined." Our species are not that difficult, by any means. If one recognizes the major groups, as outlined below, each species can be recognized in turn by a few key characters, both macroscopic and microscopic. With some practice, most of our species can be recognized even in the field. The structure and taxonomy of the genus is admirably explained by Blomquist (Jour. Elisha Mitchell Sci. Soc. 54: 1-21. 1938).

The genus may be divided into two easily recognized subgenera: The INOPHLOEA include those species with robust, turgid branches and broad, concave,

obtuse, and cucullate branch leaves which are roughened at back near the apex because of extensive "resorption" of the walls of hyaline cells and bordered by a row of cells which appear to be linear because of resorption along their outer margins (looking like a furrow in cross-section); the cortical cells of stems and branches are reinforced on the inside by spiral fibrils. (Our species are *S. magellanicum, S. centrale, S. papillosum,* and *S. palustre*.) The LITOPHLOEA are a larger and more diverse group. They have more slender branches with narrower, mostly pointed leaves which are not cucullate and not roughened at the back of the apex; the border of the branch leaves consists of linear cells in two or more rows (or exceptionally of a single row of cells resorbed at their margins); the cortical cells of stems and branches are not fibrillose. This is an artificial grouping because of the intermediate nature of the *S. compactum* group, which has branch leaves with broad, though truncate tips and a border formed by resorption, although the cortical cells are not fibrillose. For this reason it is useful to divide our species into smaller, more homogeneous sections: PALUSTRIA or, more correctly, SPHAGNUM (*S. magellanicum, S. centrale, S. papillosum,* and *S. palustre*). RIGIDA (*S. compactum*). POLYCLADA (*S. wulfianum*). SQUARROSA (*S. squarrosum* and *S. teres*). CUSPIDATA (*S. riparium, S. recurvum, sensu lato, S. pulchrum, S. cuspidatum, S. majus,* and *S. annulatum* var. *porosum*). SUBSECUNDA (*S. subsecundum, sensu lato*). ACUTIFOLIA (*S. fimbriatum, S. girgensohnii, S. russowii, S. warnstorfii, S. fuscum, S. capillaceum,* and *S. subnitens*).—Modifications of this subdivision appear, for example, in Andrews (Bryol. 14: 72-75. 1911; North American Flora 15(1): 1-31. 1913; Ann. Bryol. 9: 3-12. 1937) and Isoviita (Ann. Bot. Fenn. 3: 199-264. 1966). Because of nomenclatural problems I have avoided assigning names of ranks for the subdivisions inserted as conveniences in the text.

The importance of the genus in bog formation is well known, but little use has been made of the distinctive spores of many species in palynological studies. Reference may be made to papers on the morphology of spores by Terasmae (Bryol. 58: 306-311. 1955) and Tallis (Trans. Brit. Bryol. Soc. 4: 209-213. 1962). The latter includes a key which is also used in Savicz-L. & Smirnova's *Handbook of Sphagnaceae of the USSR*, pp. 105-109 (in Russian).

Krutsch (*Atlas der mittel- und jungtertiären dispersen* Sporen . . . 1963) was able to distinguish fossil spores of *Sphagnum* and microspores of *Selaginella* and also to assign the *Sphagnum* spores to taxonomic sections.

*Sphagnum* spores are discharged by an air gun mechanism resulting from an internal pressure of 4-6 atmospheres—a pressure similar to that carried in the huge tires of heavy trucks! It is small wonder that the spores are emitted in audible puffs, like the snapping of a wheat straw, and hurled a distance of about three centimeters (and no doubt more). Spores discharged by such an explosive means are more likely to be stopped in an ecologically suitable place close at hand rather than face the uncertainties of long distance dispersal. Another advantage may be a greater likelihood that both sexes will be established close at hand.

*Sphagnum* is exceedingly important in nature. It controls and impedes drainage of the vast North. Its effect on permafrost and maneuverability in the arctic is immense. It controls some kinds of hydrarch successions, not only by its remarkable ability to soak up water but also by creating an acid habitat for itself and other plants active in the development of bogs. This is done by an exchange of hydrogen ions for other cations (especially $Ca^{++}$ and $Mg^{++}$, less readily $K^{+}$ and $Na^{+}$) so that the species can flourish even in proximity to highly basic waters. The first invaders are usually sedges, but the acidity which gives direction to bog succession is provided by *Sphagnum,* with different species in control at each stage of succession toward drier and more acid conditions. Peat mosses are of basic importance in the mountains in controlling erosion of slopes and flooding of valleys. They are important in the seeding of trees and other plants and in the developmental succession of forests.

*Carex* and other bog plants are usually more important than *Sphagnum* in providing the bulk of peat cut for fuel. (Irish immigrants to North America were said to bring with them some of the old sod of home. The Emerald Isle, of course, provides just the right "Atlantic" type of climate for the abundant growth of *Sphagnum* and the formation of peat. The fragrance of peat fires is said to be one of Ireland's attractive features.) *Sphagnum* steeped in tar was used in the Scottish Highlands for caulking boats, and in northern Europe *Sphagnum* moss was stuffed between timbers of houses to deaden sound. *Sphagnum* also has importance in potting, mulching, and packing. During the First World War dried *Sphagnum* was used extensively for surgical dressings, thus freeing cotton for the manufacture of gun powder; see Hotson (Science, N.S. 48: 203-208. 1918; Puget Sound Biol. Sta. Bull. 2: 211-247. 1919; Bryol. 24: 74-78, 89-96. 1921), Nichols (Bryol. 21: 53-56, 81-83. 1918 and Publ. Smithsonian Inst. 2558: 221-234. 1920), and Porter (Intern. Jour. Surgery 30: 129-135. 1917). Other uses, direct or indirect, have included bedding, food and litter for livestock, medicinal baths, and the production of gunpowder, fireworks, paint, paper, insulation, fabrics, charcoal, nitrates, ammonium compounds, sugar, alcohol, and dyes; see Davis (U.S. Dept. of Interior Bureau of Mines Bull. 16: 1-214. 1911), Thieret (Econ. Bot. 10: 75-91. 1956), and Welch (Proc. Indiana Acad. Sci. 58: 31-46. 1948).

It is said that Eskimos use *Sphagnum* in lieu of socks and diapers. Stark, in *A Popular History of British Mosses,* quaintly records information on uses of *Sphagnum* in Lapland (taken from Linnaeus' *Flora of Lapland*): "The Lapland matrons are well acquainted with this moss. They dry and lay it in their children's cradles, to supply the place of bed, bolster, and every covering; and being changed night and morning, it keeps the infant remarkably clean, dry, and warm. It is sufficiently soft of itself, but the tender mother, not satisfied with this, frequently covers the moss with the downy hairs of the reindeer, and by that means makes a most delicate nest for the new-born babe."

Even recently the Chippewa Indians of Lac Vieux Desert in Michigan's Upper Peninsula put dry moss or pulverized rotten wood between the thighs of babies to keep them clean.

Good accounts of bog ecology are presented by Transeau (Bot. Gaz. 40 (July-Dec.): 351-375, 418-448. 1905; 41 (Jan.-June): 17-42. 1906), Rigg (Bot. Rev. 6: 666-693. 1940; 17: 109-131. 1951), Gates (Ecol. Monogr. 12: 213-254. 1942), Potzger (*Bogs of the Quetico-Superior Country* . . . 1950), Dansereau & Segadas-Vianna (Canad. Jour Bot. 30: 490-520. 1952), Heinselman (Ecol. Monogr. 33: 327-374. 1953), Newbould (New Biol. 26: 88-105. 1958), Ketchledge (N.Y. State Conserv. June-July 1964, 4 pp.). Other papers of worth include several listed in the bibliography, by Conway, Lange, Osvald, Rose, and Sjörs.

Useful keys have been published by Duncan, Fearnsides, Gams, Nyholm, and Proctor. Andrews' monograph in the *North American Flora* (1913) is the best reference for North America as a whole and useful for the entire Northern Hemisphere.

1. Branches stout and tumid; branch leaves very broad, broadly pointed or truncate, mostly cucullate-concave, not bordered by linear cells but with a marginal resorption furrow
   2. Cortical cells of stems and branches without spiral fibrils; leaves broadly truncate at the apex, concave but not cucullate ..... 5. *S. compactum*
   2. Cortical cells fibrillose; leaves rounded and cucullate at the apex
      3. Green cells of branch leaves triangular in section, with the base exposed on the inner surface ..... 4. *S. palustre*
      3. Green cells of branch leaves oval to elliptic in section, equally exposed or included
         4. Green cells truncately elliptic or trapezoidal, exposed on both surfaces or more broadly on the inner surface; walls of hyaline cells usually papillose on the inside where adjacent to green cells ..... 3. *S. papillosum*
         4. Green cells central; walls of hyaline cells smooth

5. Plants generally reddish; green cells shortly elliptic, central and entirely included; hyaline cells not or very slightly convex 1. *S. magellanicum*
5. Plants whitish-green; green cells narrowly long-elliptic or lenticular, central but with thickened end walls which reach both surfaces; hyaline cells slightly convex, especially on the outer surface 2. *S. centrale*

1. Branches more slender; branch leaves narrower, acuminate, concave or involute but not cucullate at the apex, bordered by linear cells, without a resorption furrow
6. Stems hard and brittle; branches crowded, in fascicles of 6-12; capitulum large and rounded 6. *S. wulfianum*
6. Stems more flexible; branches not particularly crowded, in fascicles of 6 or less; capitulum not particularly large and rounded
7. Hyaline cells of stem leaves extensively resorbed, especially on the outer surface, resulting in a broad-meshed pattern of perforations, the apex of the leaf not or only slightly fringed; apical bud large; hyaline cells of branch leaves typically very finely papillose on inner walls adjacent to green cells
8. Plants large; stem cortex in 2-3 layers; branch leaves ovate-hastate, squarrose from a broad, erect base 7. *S. squarrosum*
8. Plants slender; stem cortex in 3-4 layers; branch leaves ovate-lanceolate, imbricate or somewhat spreading, especially when dry 8. *S. teres*

7. Hyaline cells of stem leaves variously resorbed (usually not much resorbed on the outer surface and the leaf apex nearly entire, or greatly resorbed on the inner surface with the apex nearly entire or rent down the middle, or resorbed on both surfaces and the apex conspicuously lacerate-fringed); apical bud mostly small, but some large and prominent; hyaline cells of branch leaves not papillose
9. Stem leaves with a single, deep, conspicuous rent or perforated area at the middle of the apex 9. *S. riparium*
9. Stem leaves entire or lacerate but not deeply rent or perforate at the middle of the apex
10. Stem leaves entire or nearly so at the apex; green cells of branch leaves exposed only or more broadly on the outer surface or, if ± equally exposed, the pigment brown
11. Green cells of branch leaves triangular in section
12. Branch leaves broadly ovate, abruptly narrowed to a broad, channeled, cuspidate apex; green cells broadly triangular in section, with the apex of the triangle reaching ½ or less the distance to the inner surface of the leaf 11. *S. pulchrum*
12. Branch leaves oblong-lanceolate, gradually narrowed to a slightly channeled or nearly plane apex; green cells isosceles-triangular, with the apex reaching the inner surface or nearly so 10. *S. recurvum*

11. Green cells truncately elliptic to trapezoidal in section
13. Green cells of branch leaves truncately elliptic to trapezoidal in section with exposure equal or somewhat broader on the outer surface; hyaline cells of branch leaves on the outer surface with many pores arranged like beads along the commissures 15. *S. subsecundum*
13. Green cells of branch leaves triangular to trapezoidal, with broader exposure on the outer surface; hyaline cells of branch leaves with much fewer pores, not arranged like beads
14. Hyaline cells of branch leaves on the outer surface with few, small, ringed pores in ends and corners 12. *S. cuspidatum*
14. Hyaline cells of branch leaves on the outer surface with rather numerous pores in 1 or 2 rows along the middle of the cells
15. Hyaline cells of branch leaves on the outer surface with numerous, large pores often in a single ± median row and also smaller pores in the corners, on the inner surface with pores few or lacking 13. *S. majus*
15. Hyaline cells of branch leaves with numerous small to medium-sized pores on the outer surface and few to several, minute ringed pores on the inner surface 14. *S. annulatum* var. *porosum*

10. Stem leaves entire or lacerate at the apex; green cells of branch leaves exposed only or more broadly on the inner surface or, if ± equally exposed, the pigment red*
16. Stem leaves somewhat to conspicuously fringed; cortical cells of stems with a single pore at the upper ends
17. Stem leaves conspicuously fimbriate at the sides and across the apex; hyaline cells of stem leaves divided 1 or more times 16. *S. fimbriatum*
17. Stem leaves ± fringed across the apex or only at the middle of the apex; hyaline cells of stem leaves not (or only rarely) divided

*See also *S. quinquefarium*, p. 364.

18. Stems not at all red below the tips; stem leaves fringed across a broad, truncate apex, with mid-basal cells greatly resorbed in a triangular, sieve-like area 17. *S. girgensohnii*
18. Stems often reddish (at least near the tips); stem leaves ± erose at the middle of a rounded apex, the mid-basal cells not conspicuously differentiated 18. *S. russowii*

16. Stem leaves not fringed or lacerate; cortical cells of stems without pores
19. Hyaline cells of branch leaves with very small, round, strongly ringed pores on the outer surface in the apical part 19. *S. warnstorfii*
19. Hyaline cells with larger, elliptic pores on the outer surface
20. Plants brown; stem leaves broadly pointed, nearly flat 20. *S. fuscum*
20. Plants green or (more commonly) red or red-tinged; stem leaves involute-pointed
21. Hyaline cells of branch leaves not conspicuously convex on the outer surface (bulging ½ or less their diameters); stem leaves with hyaline cells ± fibrillose, not divided or 1-divided (and rarely subdivided); branch leaves not lustrous when dry 21. *S. capillaceum*
21. Hyaline cells of branch leaves bulging on the outer surface about 2/3 their diameters; stem leaves with hyaline cells not fibrillose, mostly once to several times divided; branch leaves with a metallic luster when dry 22. *S. subnitens*

I. Cortical cells of stems and branches fibrillose, those of the branches porose but not retort-shaped; leaves lacking a border of narrow cells, with resorption furrow; stem and branch leaves similar, cucullate, roughened near the apex at back because of extensive resorption of hyaline cells; perichaetial leaves with a lower median zone of uniformly narrow cells surrounded at the sides and apex by a network of fibrillose and porose hyaline cells in a network of green cells.

1. **Sphagnum magellanicum** Brid.—Robust, usually reddish or purplish plants (pale-green in the shade), hummock-forming. Wood cylinder red; cortical cells of stems in 3-4 layers, fibrillose, with 1 pore at the upper end of nearly every outer cell. Stem leaves large, lingulate, with hyaline cells not divided, not fibrillose or sometimes only near the leaf apex, mostly resorbed on the outer surface. Branches in fascicles of 4-5 (2 spreading), with cortical cells in 1 layer, fibrillose, often with 1 large pore. Branch leaves broadly ovate, concave-cucullate, denticulate, with a resorption furrow; hyaline cells plane or nearly so on both surfaces, on the inner surface with a few corner pores, on the outer surface with numerous, large, elliptic pores in the corners and along the commissures; in section, green cells small, shortly elliptic, central, entirely included. Dioicous. Spores 22-31 $\mu$, minutely or obscurely papillose.—n = ca. 17-19, 19, 38+3.

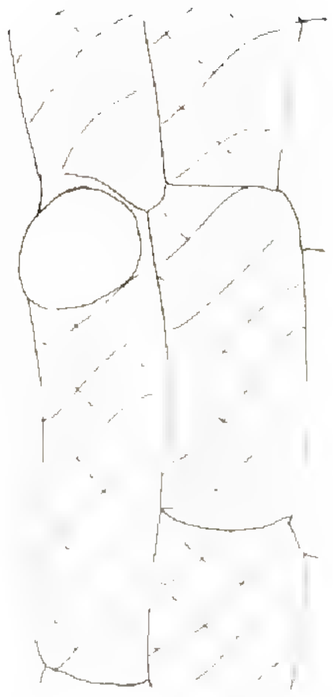
Breen, Mosses of Florida, Pl. 125 (fig. 1-7). Darlington, Mosses of Michigan, fig. 3. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 2 (as *S. medium*), (ed. 2) Pl. 3. Welch, Mosses of Indiana, fig. 10.—**Fig. 1-8.**

Typically in open parts of bogs, relatively oligotrophic. Greenland; Labrador to Alaska, south to the Gulf of Mexico and California; Guatemala and Costa Rica; Jamaica and Santo Domingo; South America to Tierra del Fuego; Falkland Islands; Europe and Asia.

CHEBOYGAN CO.—Hermits Bog, Iron Bridge (Carp Creek), Gleasons Bog, Bryants Bog, Gates Bog, Nichols Bog, Livingston Bog, Mud Lake, Hebron Swamp, Little Lake 16, Weber Lake. EMMET CO.—Maple River, Stutsmanville, Carp Lake, between Levering and Carp Lake, Wycamp Lake, Big Stone Bay, Conway Bog, Bear Creek Township. MACKINAC CO.—Hiawatha Sports Club, Peggley Lake, Cranberry Lake, Hendricks, Little Dollar Lake, Mud Lake, Rexton Lake, Prentiss Bay. PRESQUE ISLE CO.—Hammond Bay, Loon Lake, Kelsey Lake, Clinton Lake.

The only one of our INOPHLOEA developing a red coloration, this common species is a significant hummock-former in open bogs. It is well characterized by the structure of its branch leaves as revealed in cross-section: the hyaline cells are nearly plane on both surfaces, and the green cells are small, elliptic, central, and completely included. *Sphagnum centrale* is a whitish-green, shade species with somewhat bulging hyaline cells and apparently central green cells which are, however, longer and lens-shaped and narrowly exposed on both surfaces because of thickened end walls.

1



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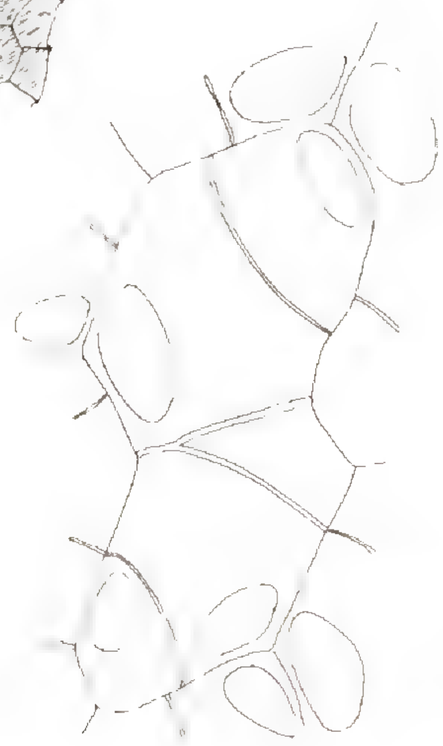

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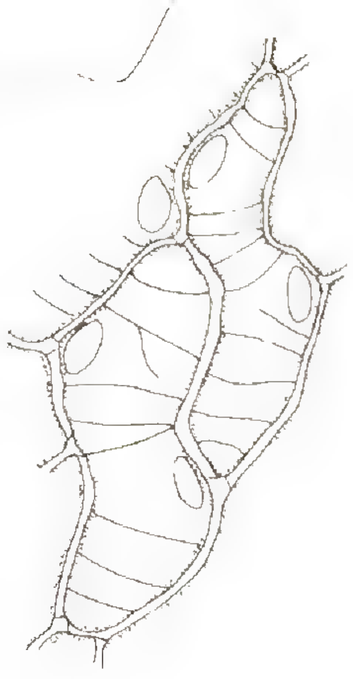

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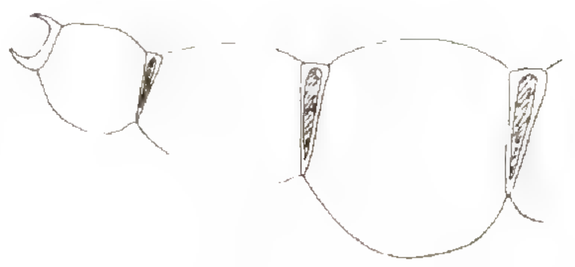


13

*Sphagnum magellanicum.* 1. Stem cortex. 2. Branch cortex. 3. Stem leaf. 4. Branch leaf. 5. Back of branch leaf tip showing resorption. 6. Cross-section of branch leaf. 7. Cells of upper median portion of branch leaf, outer surface. 8. Cells at margin of branch leaf near its apex, outer surface.

*Sphagnum centrale.* 9. Cross-section of branch leaf.

*Sphagnum papillosum.* 10. Cells of branch leaf, inner surface. 11. Cells of branch leaf, outer surface. 12. Cross-section of branch leaf.

*Sphagnum palustre.* 13. Cross-section of branch leaf.

2. **Sphagnum centrale** C. Jens.—Robust, usually whitish-green or yellowish to pale-brownish plants, never red. Wood cylinder green or brownish; cortical cells of stems in 3-4 layers, fibrillose, the outer cells with 1-3 (sometimes 4 or more) pores. Stem leaves large, oblong-obovate, concave; hyaline cells undivided, not fibrillose. Branches in fascicles of 4-5 (2 spreading), with cortical cells in 1 layer, fibrillose, usually with a single pore. Branch leaves broadly ovate, concave-cucullate, denticulate, with a resorption furrow; hyaline cells slightly convex on the inner surface, somewhat more so on the outer, on the inner surface with 2-6 round to elliptic, ringed pores at the ends and along the commissures, on the outer surface similar, with 2-3 often grouped at contiguous corners; in section, green cells slender and lenticular to elliptic,

usually nearly reaching both surfaces or the end walls thickened and reaching both surfaces. [Presumably dioicous.] Spores about 26-30 $\mu$, finely roughened or nearly smooth.–n = 38+?

Darlington, Mosses of Michigan, fig. 4.–**Fig. 9.**

In shady places, especially in bog forests but also found on open mats among scattered spruce and tamarack trees. Circumpolar; widespread in northern North America, south to New York and Indiana.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge (Carp Creek), Livingston Bog, Gates Bog, Ingleside, Mud Lake, Little Lake 16, Grass Lake, Weber Lake, Pinegrove State Forest Campground. EMMET CO.–Pleasantview Swamp, Stutsmanville, Galloway Bog, between Levering and Carp Lake, Carp Lake, Conway Bog, Bear Creek Township, Wycamp Lake, Big Stone Bay. MACKINAC CO.–Prentiss Bay, Hog Island Point, Epoufette, Hiawatha Sports Club, Peggley Lake, Rexton, McNamara Pond, Little Dollar Lake. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Presque Isle Corporation, Kelsey Lake, Clinton Lake.

A whitish-green species of shaded habitats much resembling *S. magellanicum* in typical form because the green cells of the branch leaves appear to be central and included, but actually they are elongate and have thickened end walls which provide a narrow exposure on both surfaces. *Sphagnum centrale* is not an entirely satisfactory species. The green cells may be narrowly triangular-trapezoidal and cause confusion with a form of *S. papillosum* lacking papillae (and this in turn approaches *S. palustre* in cross-section). The hyaline cells of the stem leaves of *S. papillosum* are subdivided (at least in the lower portions of leaves), and those of the branch leaves have numerous fibrils and few pores; in *S. centrale,* the hyaline cells of the stem leaves are undivided, and those of branch leaves have few fibrils but numerous pores.

Several local collections of *S. centrale* and *S. cuspidatum* have noticeably small capsules with small, spherical, reticulate or papillose spores (about 11-13 $\mu$). The spores actually belong to a fungus, *Tilletia sphagni* Naw. (which is a conidial stage of the discomycete *Helotium schimperi* Naw.). Similar spores in several members of the ACUTIFOLIA were erroneously considered by Warnstorf (Hedwigia 25: 89-92. 1886) to be microspores resulting from a subdivision of spore mother cells forming 16 rather than the normal four spores. (I have also seen *Tilletia* spores in capsules of *S. perichaetiale* Hampe from Virginia.)

3. **Sphagnum papillosum** Lindb.–Plants slender to robust, usually yellowish or brownish, hummock-forming. Wood cylinder brown or blackish; cortical cells of stems in 3-4 layers, thin-walled, weakly fibrillose, the outer cells rarely with more than 1-2 pores. Stem leaves lingulate, short or long; hyaline cells frequently divided, not or somewhat fibrillose (if not, the outer walls largely resorbed). Branches in fascicles of 4-5 (2 spreading), with cortical cells in 1 layer, fibrillose, often with a single large pore at the upper ends. Branch leaves imbricate or slightly spreading, broadly ovate, cucullate-concave, denticulate at the margins, with a resorption furrow; hyaline cells somewhat convex on the outer surface, finely papillose on the inside where adjacent to green cells (or the papillae often reduced or lacking), on the inner surface with many small, ringed pores in the angles and often in apical and lateral regions of the leaf with 1-5 large, round pores along the cell middle, on the outer surface with 4-10 rounded or elliptic pores in the corners and along the commissures; in section, green cells truncately elliptic to trapezoidal or nearly triangular, ± equally exposed or exposed more broadly on the inner surface (the sides ± curved). Dioicous. Spores 31-36 $\mu$, papillose.–n = 38+4.

Darlington, Mosses of Michigan, fig. 5. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 2.–**Fig. 10-12.**

In wet bog situations, but typically in the open, especially at or near the margins of bog lakes; mesotrophic or relatively eutrophic. Greenland; Labrador to North Carolina and the Great Lakes; Alaska and British Columbia; Brazil; Europe and Asia.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge (Carp Creek), Gates Bog, Nichols Bog, Mud Lake, Topinabee, Little Lake 16, Weber Lake. EMMET CO.–Gladys Bog, Galloway Bog, Conway Bog, Stutsmanville. MACKINAC CO.–Rexton Lake, Little Dollar Lake, McNamara Pond, Cranberry Lake. PRESQUE ISLE Co.–Evergreen Beach.

Plants typically growing in wetter, exposed, and mineral rich parts of bogs and recognizable in the field, with reasonable certainty, because of a brownish tinge. Microscopically, the species offers problems. The green cells of the branch leaves, as viewed in section, are more or less trapezoidal to nearly triangular, and they are usually finely and densely papillose on inner walls where they are adjacent to hyaline cells. Often, however, in the so-called var. *laeve* Warnst., the papillae are difficult to demonstrate or even lacking, and confusion with *S. palustre* and sometimes *S. centrale* is common. Cardot (Bull. Soc. Roy. Bot. Belg. 25(1): 19-136. 1886) commented that *S. papillosum* without papillae is no more than *S. cymbifolium* (= *S. palustre*). Meylan (Rev. Bryol. et Lichén. 7: 184-187. 1935) came to the conclusion that *S. papillosum*, though generally recognizable by its brown color, is really only a variety of *S. palustre*, because of a similarity in leaf sections and variability in papillosity.

However, the hyaline cells of the stem leaves, frequently divided in *S. papillosum*, are usually quite undivided in *S. palustre*, *S. centrale*, and *S. magellanicum*. *S. centrale* is usually not too difficult to recognize because the green cells of the branch leaves have thickened end walls exposed on both surfaces. The green cells of *S. palustre* are really triangular and not triangular-trapezoidal. The differences are tedious but cause little trouble locally, as *S. palustre* is very rare!

An important hummock former in Europe and some other parts of the United States is a similar species offering similar problems in identification, **S. imbricatum** Hornsch. *ex* Russ. (It has green cells which are equilateral-triangular in section; the "fringe fibrils" on the inner walls of hyaline cells adjacent to the green cells may be entirely lacking, poorly developed, or very obvious.) The marvelous scanning electron photomicrographs published by Mozingo *et al.* (Bryol. 72(4): 484-488. 1969) are illustrative of all the INOPHLOEA. The details of the hyaline cells and pores of branch leaves are beautifully shown.

4. **Sphagnum palustre** L.–Plants low to robust, green or uncommonly brownish-tinged. Wood cylinder brown; cortical cells of stems in 3 layers, thin-walled, fibrillose, the outer cells with 1-4 (and often more) irregularly rounded pores. Stem leaves large, long-lingulate to subspatulate; hyaline cells not divided, often somewhat fibrillose above, resorbed on the outer surface. Branches in fascicles of 4-5 (2 spreading), with cortical cells in 1 layer, fibrillose, frequently with 1 large pore. Branch leaves imbricate to squarrose, cucullate-concave, broadly ovate, denticulate, with a resorption furrow; hyaline cells somewhat convex on the outer surface, on the inner surface with elliptic to round pores in the corners and a few large, round pores at the middle, more numerous (2-8) near the leaf margins, on the outer surface with large, round pores at the ends and numerous (3-10), smaller, elliptic, ringed ones along the commissures; in section, green cells isosceles-triangular and nearer the inner surface). Dioicous. Spores about 24-29 $\mu$, finely roughened or nearly smooth.–n = 38+?, 38+4.

Breen, Mosses of Florida, Pl. 126. Darlington, Mosses of Michigan, fig. 6. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 1 (as *S. latifolium*), (ed. 2) Pl. 1 (as *S. palustre*). Welch, Mosses of Indiana, fig. 11.–**Fig. 13.**

In shade in bog forests or sometimes in semi-open parts of bog mats, tolerating a wide range of acid conditions. Newfoundland through the Great Lakes and south to the Gulf of Mexico; Mexico; Europe and Asia.

CHEBOYGAN CO.–Vincent Lake, Weber Lake.

Andrews considered *S. palustre* the most common of the INOPHLOEA in the Northern Hemisphere and said that anyone collecting *Sphagna* in North America would want directions for avoiding it! However, his concept (Bryol. 25: 7-8. 1912) included the typical form with green cells of branch leaves unmistakably triangular in section and other forms with more or less triangular-trapezoidal cells. *S. palustre* is actually uncommon in Michigan and very rare locally. The form with trapezoidal or somewhat triangular green cells is common, however, and is considered here as a non-papillose form of *S. papillosum.*

II. Cortical cells of stems and branches without fibrils, some or all of those of branches retort-shaped; leaves generally bordered by narrow cells, nearly always lacking a resorption furrow; branch leaves not cucullate but tending to be truncate and toothed at a typically narrow apex; perichaetial leaves consisting of uniformly narrow cells in the border and usually also in the apex or nearly throughout.

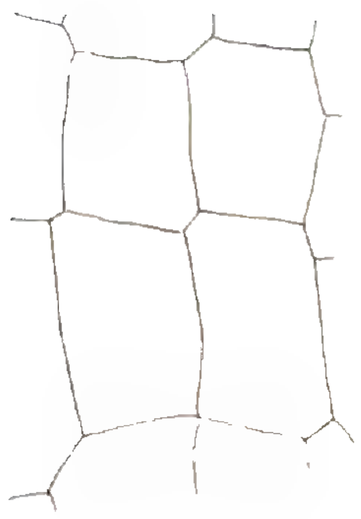
A. Cortical cells of branches all ± uniform and somewhat retort-shaped; branch leaves with a resorption furrow, lacking a border of narrow cells.

5. **Sphagnum compactum** DC.–Plants usually short and compact, dirty-white (especially when dry), sometimes pale-green or brownish-tinged. Wood cylinder brown; cortical cells of stem in 2-3 layers, thin-walled, without fibrils or pores. Stem leaves minute (less than 1 mm. long), concave, bluntly triangular-lingulate, sometimes ± lacerate at apex; hyaline cells not divided, without fibrils. Branches short, crowded, in fascicles of 4-5 (2 spreading or ascending), with cortical cells in 1 layer, without fibrils, the apex of each cell projecting as a slight neck ending in a pore. Branch leaves imbricate to squarrose, large, involute-concave, broadly ovate-hastate, ending in a broad, truncate, toothed apex which is concave but not cucullate, slightly denticulate at the margin, with a resorption furrow; hyaline cells somewhat convex on the inner surface, not or slightly so on the outer surface, on the inner surface with ringed pores in the corners (usually 3 per cell and occurring as 3's at adjoining corners), on the outer surface with 4-8 large, round pores mostly enclosed within a subdivision limited by a fibril thickening and also with numerous similar subdivisions lacking a perforation, thus forming pseudopores; in section, green cells elliptic, central or nearer the outer surface, included. Monoicous. Spores 25-33 $\mu$, very finely roughened or nearly smooth.–n = 19+2, 19+2-4.

Darlington, Mosses of Michigan, fig. 7. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 2 & (ed. 2) Pl. 3 (as var. *squarrosum*). Welch, Mosses of Indiana, fig. 13.–**Fig. 14-21.**

In moist to relatively dry habitats, especially at the outer margins of open *Chamaedaphne* bogs and sometimes on banks of ditches in boggy areas; oligotrophic. Greenland; Labrador through the Great Lakes and south to the Gulf of Mexico; Alaska and British Columbia; Azores and Madeira; Europe and Asia.

CHEBOYGAN CO.–Near Douglas Lake, Gates Bog. EMMET CO.–French Farm Lake, between Levering and Carp Lake.



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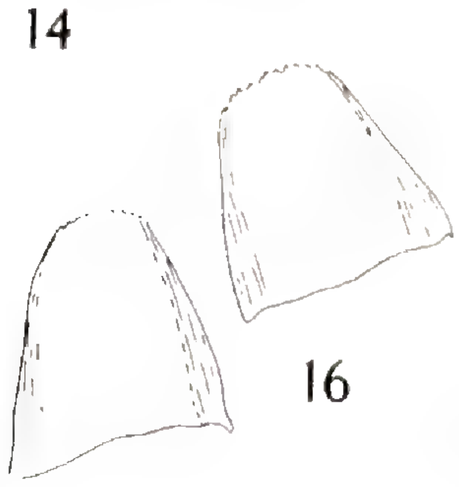

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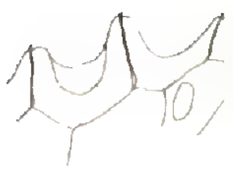

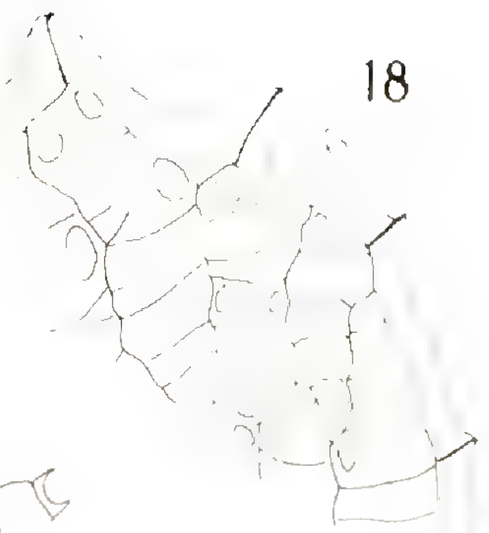

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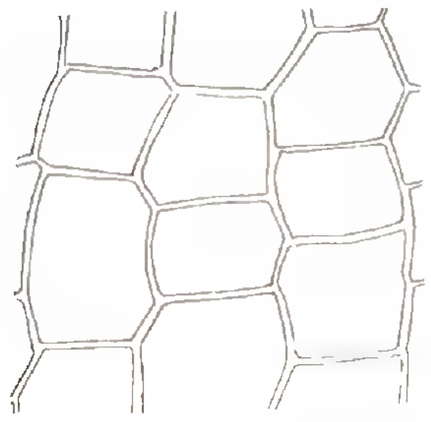

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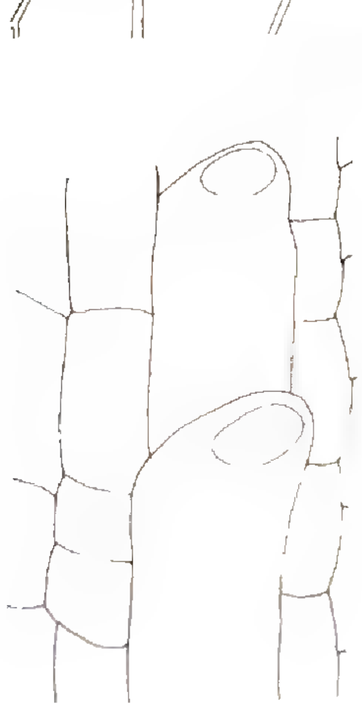

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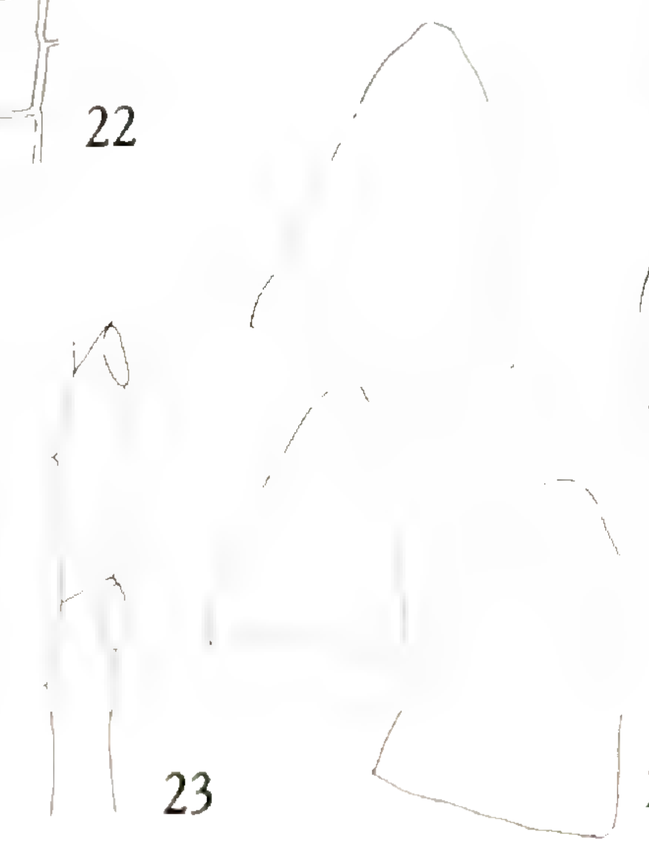

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*Sphagnum compactum.* 14. Stem cortex. 15. Branch cortex. 16. Stem leaf. 17. Branch leaf. 18. Cells at margin of branch leaf apex showing resorption. 19. Cross-section of branch leaf. 20. Cells of branch leaf, inner surface. 21. Cells of branch leaf, outer surface.

*Sphagnum wulfianum.* 22. Stem cortex. 23. Branch cortex, in surface and in profile (right). 24. Stem leaves. 25. Branch leaves. 26. Cross-section of branch leaf. 27. Cells of branch leaf, inner surface. 28. Cells of branch leaf outer surface.

Although the leaves are margined by a resorption furrow, as in the INOPHLOEA, they are more or less truncate at the apex and smooth at the back, and the cortical cells of stems and branches are not fibrillose. The compact, pin-cushion manner of growth, relatively large and fleshy-looking leaves, as well as a washed-out whitish color are suggestive of the genus *Leucobryum.* The species is further distinguished by branch leaves with nearly central green cells and hyaline cells with large pores arranged in 3's at adjacent corners on the inner surface. Plants growing in the shade have a looser habit and spreading leaf tips.

B. Cortical cells of branches usually of two types, the retort cells only in axils of leaves (1-2 per leaf axil) or apparently lacking; branch leaves usually bordered by narrow cells, only rarely with a resorption furrow.

a. Stem leaves much shorter than branch leaves. Branches 6-12 in a fascicle, crowded in a large capitulum; green cells of branch leaves truncately elliptic in section, ± equally exposed on both surfaces.

6. **Sphagnum wulfianum** Girg.–Plants loosely tufted, rather robust, dark-green tinged with brown. Stems dark, stiff and brittle. Terminal bud not conspicuous. Wood cylinder red-brown; cortical cells of stem in 2-4 layers, rather small, with moderately thick walls, without fibrils or pores. Stem leaves very small, oblong-triangular, slightly concave, involute to an abruptly pointed apex, narrowly bordered; hyaline cells without fibrils, often divided. Branches crowded in fascicles of 6-12 (3 or more spreading), with cortical cells in 1 layer, without fibrils; retort cells with a short neck. Branch leaves with points spreading when dry, small, narrowly ovate-lanceolate, involute-tubulose to a sharp point toothed across the apex, entire, bordered by 2-3 rows of narrow cells; hyaline cells very slightly convex, more so on the outer surface, very finely papillose on the inside where overlying green cells, on the inner surface with few (rarely 3-4), inconspicuous pores in the ends and corners, on the outer surface with small, ringed pores along the commissures (4-8 per cell in the upper half of the leaf, generally fewer below); in section, green cells truncately elliptic, equally exposed on both surfaces or slightly more broadly on the outer surface (the lumen lenticular, central). Dioicous or sometimes monoicous. Spores 18-24 $\mu$, finely granulose-roughened.–n = 19+5.

Darlington, Mosses of Michigan, fig. 8. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 2. Sullivant, Icones Muscorum Supplement, Pl. 9.–**Fig. 22-28.**

In bog forests, usually on low ridges resulting from logs in an advanced state of decay, rarely in open bogs. Greenland; southeastern Canada to Connecticut and the Great Lakes; Alberta and British Columbia; Europe and Asia.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gleasons Bog, Gates Bog, Livingston Bog. EMMET CO.–Antique Bog, Stutsmanville, Wycamp Lake, Conway Bog. MACKINAC CO.–Prentiss Bay, Epoufette, Rexton Lake, Hog Island Forest Campground, Hendricks, McNamara Pond. PRESQUE ISLE CO.–Hammond Bay, Clinton Lake.

The plants are loosely tufted and appear top heavy because of an exceptionally large, rounded capitulum resembling a head of clover (resulting from an unusually high number of branches in each fascicle as well as a crowding of fascicles). Further distinctive traits are furnished by dark, woody, brittle stems and tips of branch leaves nicely curved outward.

b. Terminal bud large. Stem leaves with a narrow border only toward the base, with extensive resorption especially on the dorsal surface resulting in a perforated or somewhat lacerate apex; perichaetial leaves also showing resorption on the dorsal surface; branch leaves generally squarrose or spreading at least when dry; green cells of branch leaves exposed exclusively or more broadly on the outer surface, the hyaline cells usually finely papillose on the inner walls adjacent to the hyaline cells.

7. **Sphagnum squarrosum** Crome–Plants robust, bright- or pale-green to yellowish, with a prominent terminal bud. Wood cylinder green to red-brown; cortical cells of stem in 2-3 layers, thin-walled, without fibrils or pores. Stem leaves large, long, oblong-lingulate, slightly concave, indistinctly bordered, weakly lacerate at the apex;

hyaline cells mostly undivided and without fibrils, with membrane pleats, the walls almost completely resorbed on the outer surface. Branches in fascicles of 5 (2 spreading), with cortical cells in 1-2 layers, without fibrils, the retort cells with an inconspicuous neck. Branch leaves wide-spreading or squarrose from an erect base, large (2-2.8 mm. long), ovate-hastate, abruptly narrowed to an involute, acute, toothed apex, bordered by linear cells, entire; hyaline cells convex on both surfaces, more so on the inner, often papillose on the inside where overlying green cells, on the inner surface with 4-10 round pores at the ends and near the commissures, on the outer surface with 1-3 per cell (except in the median basal region where they are large and up to 10 or more); in section, green cells triangular with the base exposed on the outer surface or trapezoidal and narrowly exposed on the inner surface as well. Monoicous. Spores 17-27 $\mu$, nearly smooth or very finely granulose.—n = 19, 19+2, 19+2-4, 19+4, 38+2-4.

Darlington, Mosses of Michigan, fig. 9. Grout, Mosses with Hand-lens & Microscope, fig. 10a. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 70.—**Fig. 29-34.**

In depressions in bog forests; eutrophic. Greenland; Labrador to Saskatchewan and Montana, south to New Jersey, Ohio, and Colorado; Alaska to California; Arizona; Europe and Asia.

CHEBOYGAN CO.—Reeses Bog, Gorge of Carp Creek, Iron Bridge (Carp Creek), Douglas Lake, Bryants Bog, Nichols Bog, Livingston Bog, Little Lake 16, Grass Lake. EMMET CO. -Ramona Beach, Wycamp Lake, between Levering and Carp Lake, Larks Lake, Cecil Bay, Big Stone Bay. MACKINAC CO.—Mackinac Island, Epoufette, Hog Island Forest Campground, Hendricks, McNamara Pond, Hessel. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach.

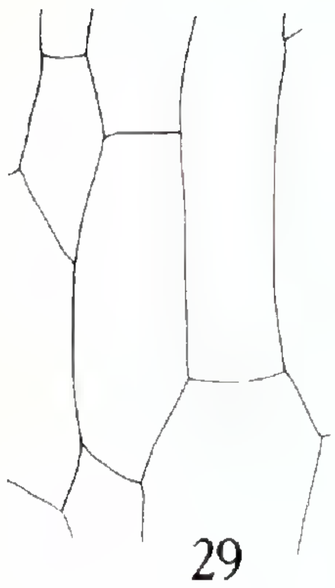
A woodland species recognizable at a glance because of its large size, bright-green color, and branch leaves abruptly narrowed and widely spreading. Like *S. teres,* to which it is closely related, it has a prominent terminal bud.

8. **Sphagnum teres** (Schimp.) Ångstr. *ex* Hartm.—Plants rather slender, mostly yellowish- or brownish-green, with a prominent terminal bud. Wood cylinder brownish or red-brown; cortical cells of stem in 3-4 layers, thin-walled, without fibrils or pores (but on staining a large rounded or elliptic pore-like thin spot can be demonstrated in each cell, or sometimes 1 at either end). Stem leaves large, ± elliptic, flat, narrowly and indistinctly bordered even at base, ± perforate or weakly fringed at the apex because of resorption, hyaline cells not divided (or rarely divided in the basal portion of the leaf), without fibrils, the walls almost entirely resorbed on the outer surface, with membrane pleats. Branches in fascicles of 5 (2-3 spreading), with cortical cells in 1 layer, the retort cells with an inconspicuous neck. Branch leaves imbricate or sometimes ± spreading or squarrose at the tips, small (1-2 mm. long), ovate-lanceolate, strongly involute toward the toothed apex, bordered by linear cells, entire; hyaline cells convex on the inner surface, often papillose on the inside where overlying green cells, with 3-6 large pores on either surface; in section, green cells triangular to trapezoidal, exposed exclusively or more broadly on the outer surface. Dioicous. Spores 20-26 $\mu$, finely granulose.—n = 19+2, 19+4.

Darlington, Mosses of Michigan, fig. 10. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 2 & (ed. 2) Pl. 3 (as var. *subteres*). Sullivant, Icones Muscorum Supplement, Pl. 4.—**Fig. 35-42.**

In wetter parts of floating mats, often in wet sedge mats near open water and also in alder thickets nearby; distinctly eutrophic. Greenland; Labrador to Alaska and south to Pennsylvania, the Great Lakes, Colorado, and California; Europe and Asia.

CHEBOYGAN CO.—Reeses Bog, Nichols Bog, Mud Lake, Little Lake 16, Weber Lake. EMMET CO.—Carp Lake. MACKINAC CO.—Peggley Lake, Rexton, Hendricks, Hog Island Forest Campground, Hiawatha Sports Club. PRESQUE ISLE CO.—Hammond Bay.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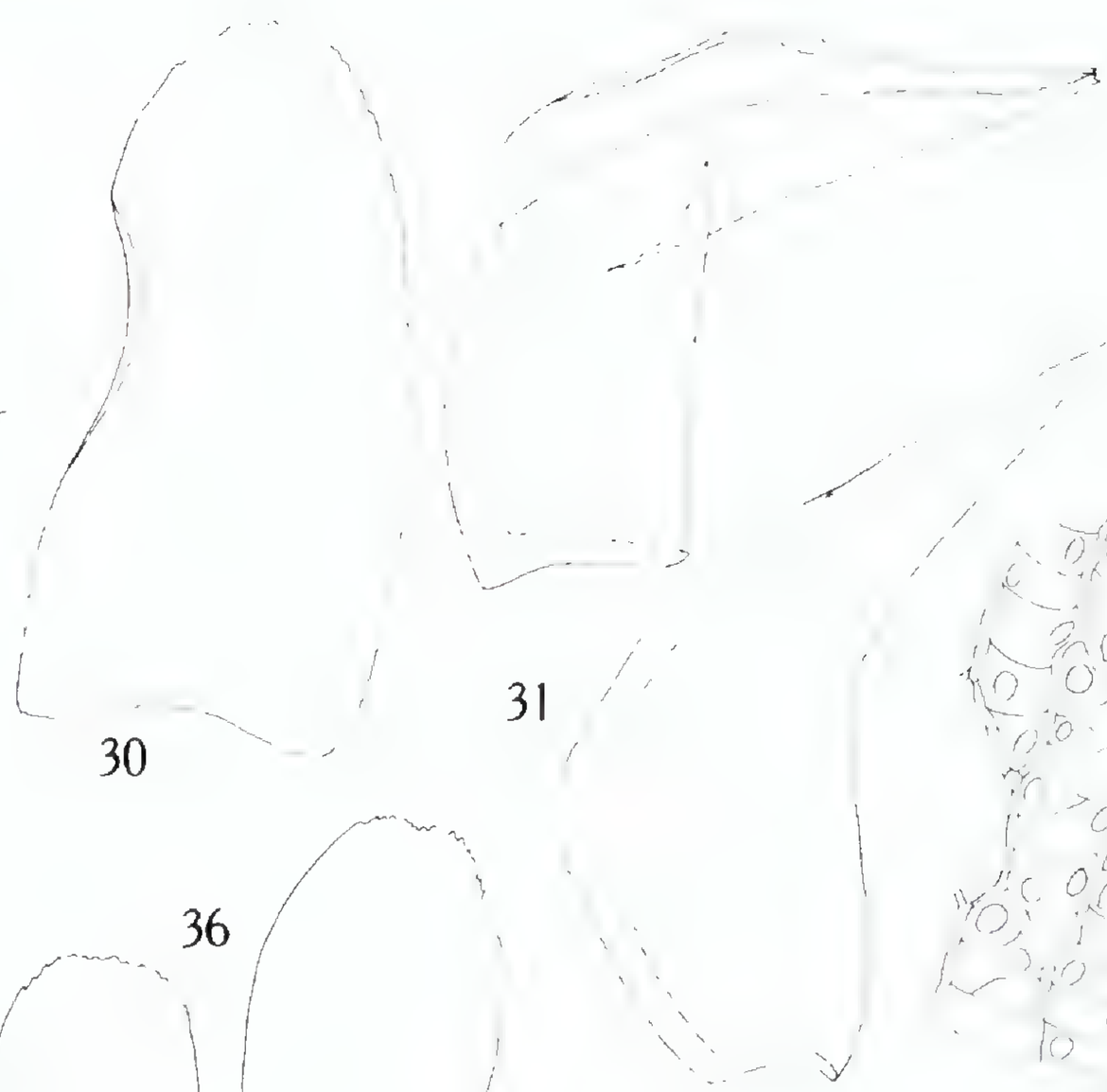
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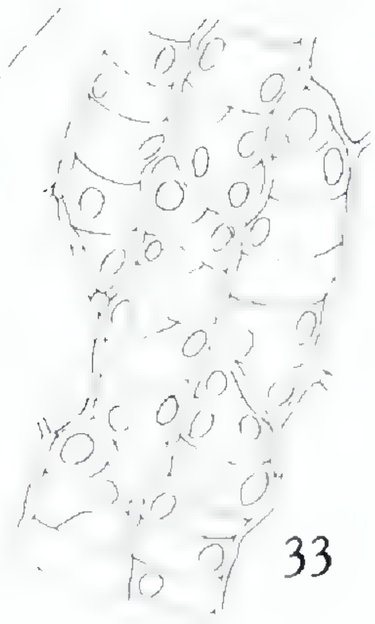
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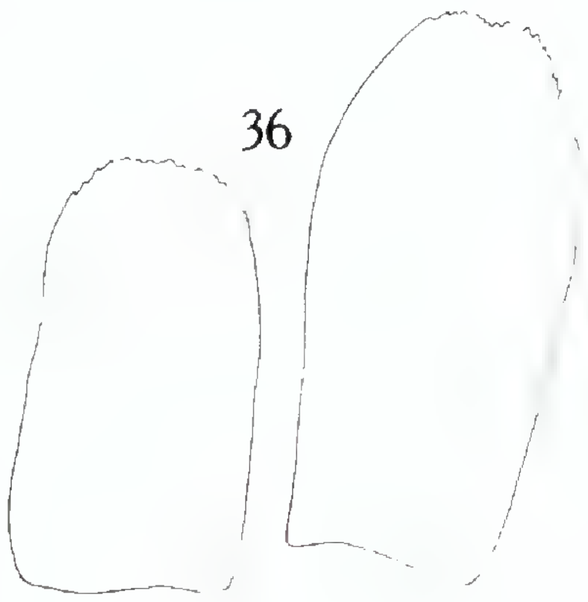
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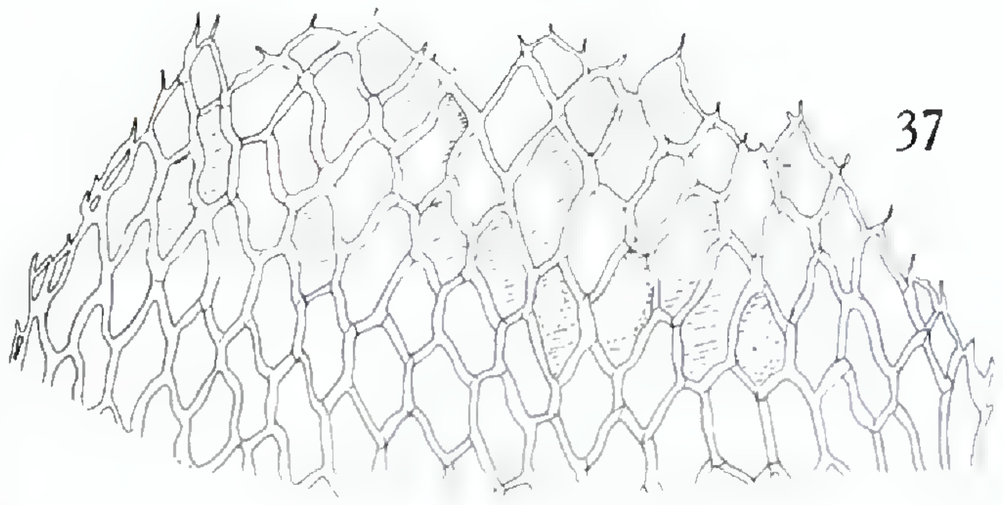
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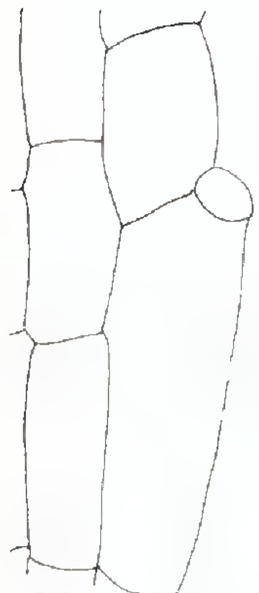
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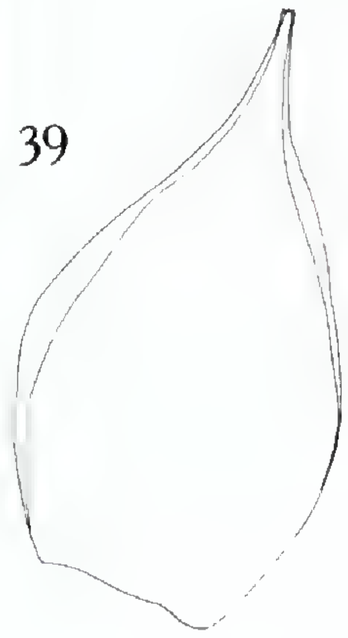
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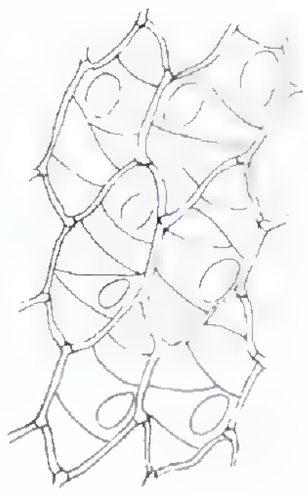
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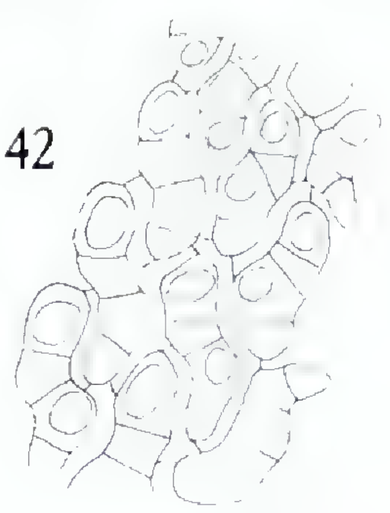
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*Sphagnum squarrosum.* 29. Stem cortex. 30. Stem leaf. 31. Branch leaves. 32. Cross-section of branch leaf. 33. Cells of branch leaf, inner surface. 34. Cells of branch leaf, outer surface.

*Sphagnum teres.* 35. Stem cortex. 36. Stem leaves. 37. Cells at apex of stem leaf. 38. Branch cortex. 39. Branch leaves. 40. Cross-section of branch leaf. 41. Cells of branch leaf, inner surface. 42. Cells of branch leaf, outer surface.

*Sphagnum teres* is recognized in the field more by elimination than by special characteristics. The plants are slender and yellowish and grow in very wet, mineral-rich habitats; they have a large terminal bud, relatively stiff, slender branches with leaves appressed when moist but more or less spreading to squarrose when dry, and red-brown stems. When growing in the shade, they tend to have more spreading leaf tips, and occasional robust forms may be difficult to distinguish from *S. squarrosum* (at least as dried specimens). Ordinarily the two species are not difficult to distinguish, however; *S. squarrosum* is stouter and bright-green, with ovate-hastate rather than ovate-lanceolate branch leaves which have smaller and more numerous pores. (A further

point of contrast is that *S. squarrosum* fruits commonly and abundantly.) Both species are most clearly differentiated from others of the LITOPHLOEA by their large, long-lingulate stem leaves with short, broad, and efibrillose hyaline cells extensively resorbed (but especially so on the outer surface) resulting in perforation and slight laceration of the apex. In keying, *S. teres* can be confused with *S. girgensohnii* because of a degree of fringing at the apex of stem leaves and because of membrane thinnings in the stem cortex resembling pores on staining. The membrane thinnings, however, are eroded and torn areas not bounded by a distinct circular wall as in *S. girgensohnii. Sphagnum girgensohnii* can also be distinguished from *S. teres* by elliptic pores on the outer surface of branch leaves, strongly bordered stem leaves with most hyaline cells divided and erosion in a conspicuous triangular area in the basal median portion, and (usually) isodiametric cells of the stem cortex. Broader exposure of green cells on the outer surface and the fine papillae on the inner walls of hyaline cells further aid in distinguishing *S. teres.*

c. Stem leaves usually bordered along the sides by several rows of elongate cells, with resorption on the inner surface, or less often on both surfaces and then lacerate-fringed; perichaetial leaves usually showing resorption on the inner surface; branch leaves often flat and ± wavy at the margins when dry; green cells of branch leaves usually with exclusive or greater exposure on the outer surface.

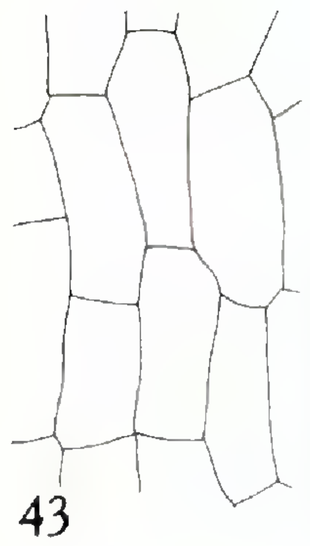
9. **Sphagnum riparium** Ångstr.—Plants robust, dark green, hard and shiny in appearance when moist. Terminal bud very large; young pendent branches in pairs between rays of the capitulum. Wood-cylinder green; cortical cells of stems scarcely differentiated, long, narrow, thick-walled, without pores or fibrils. Stem leaves rather large, broadly oblong-triangular to elliptic, deeply rent or conspicuously perforate at the middle, bordered by 4-6 rows of narrow cells; hyaline cells often divided once or twice, especially toward the leaf apex, without fibrils, the membrane on the inner surface almost entirely resorbed. Branches in fascicles of 4 or 5 (2 spreading), their cortical cells in 1 layer, nonfibrillose, of 2 kinds, the retort cells with an inconspicuous neck. Branch leaves when dry slightly undulate with tips reflexed, ovate-lanceolate, involute to a narrow, toothed apex consisting entirely of green cells, bordered by 2-5 rows of linear cells, without a resorption furrow; hyaline cells somewhat convex on the outer surface, nearly plane on the inner, and on the inner surface with rounded pores mostly of nearly cell width at the ends and elsewhere, on the outer with small pores at ends and corners (3-5 per cell in the upper portion of the leaf); in section, green cells trapezoidal with broader exposure on the outer surface, the lumen triangular. Dioicous. Spores about 20-30 $\mu$, minutely roughened.—n = 19+4.

**Fig. 43-50.**

Rare, in wet, relatively acid habitats, especially at margins of ponds and in sedge mats near open water; mesotrophic or perhaps oligotrophic. Circumpolar; Greenland; Labrador to Alaska, south to New Hampshire, New York, Michigan, and Washington.

EMMET CO.—Stutsmanville Bog.

Large, dark-green, hard and shiny when moist, *S. riparium* is much stouter than *S. recurvum* and otherwise distinguished by a large terminal bud and turgid branches with pointed tips and broad, imbricate leaves narrowed to a small, recurved tip and not undulate. The leaf tip consists of uniformly narrow, green cells rather than the usual network of green and hyaline cells. The most striking feature of the species is the large stem leaves which are deeply and conspicuously perforate or split at the middle of the apex. The pairing of young pendent branches, observable between the rays of the capitulum, is a good field character for *S. riparium, S. recurvum,* and *S. pulchrum.*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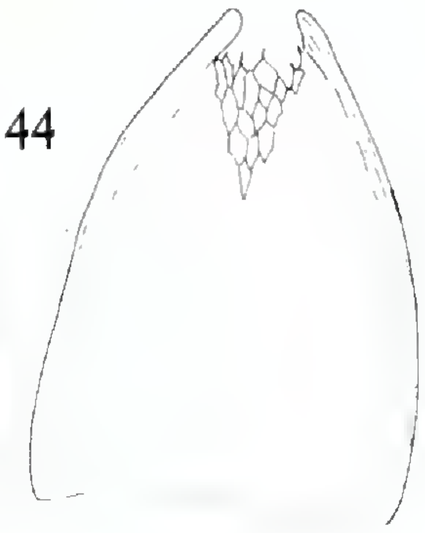

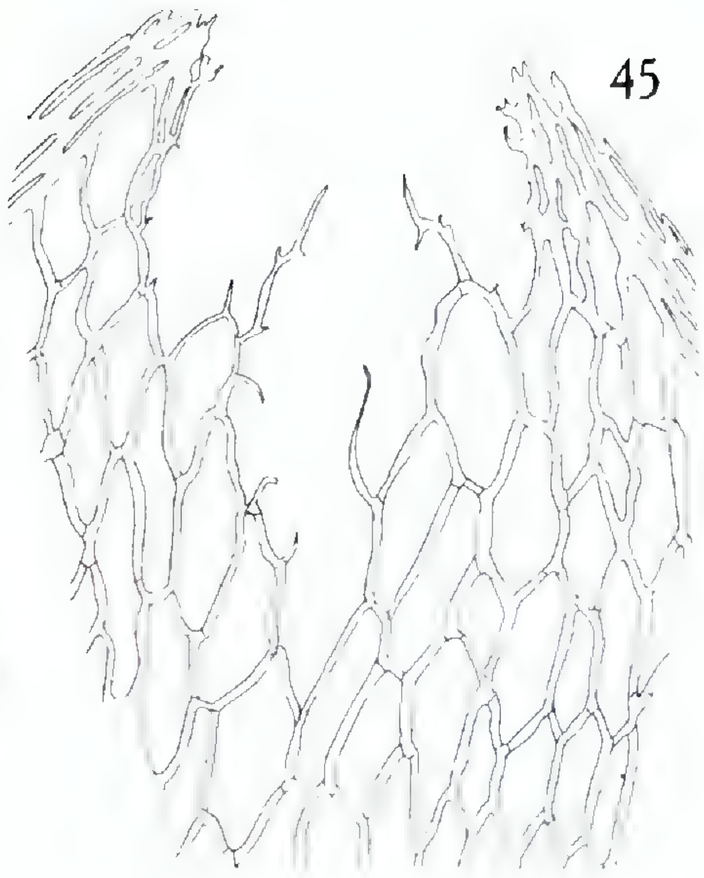
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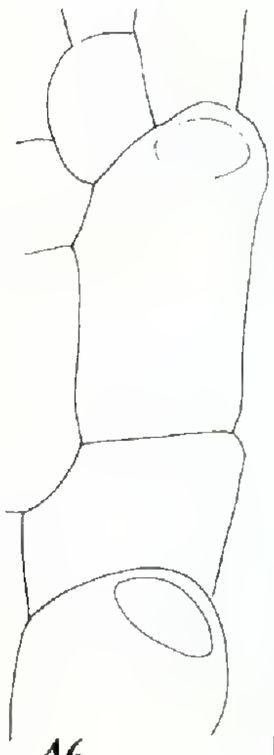
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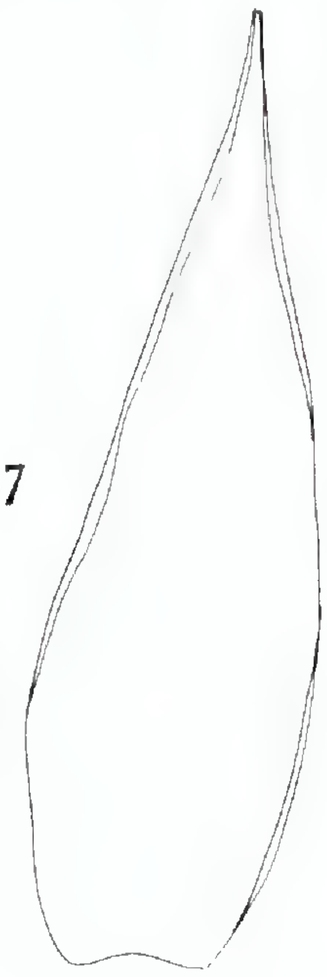

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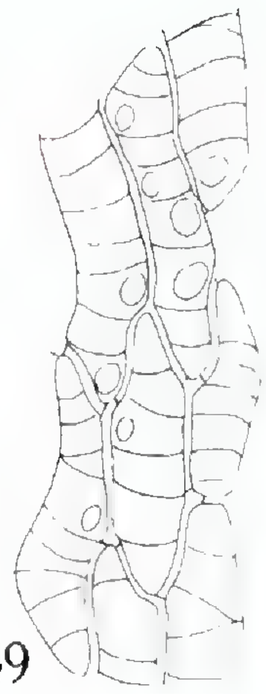
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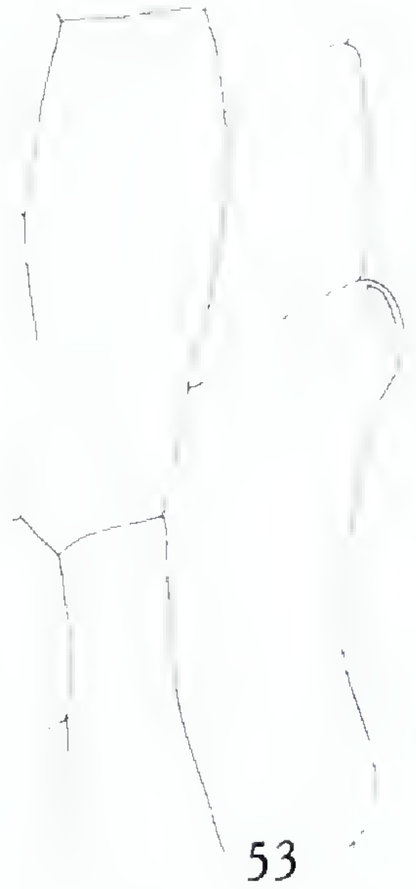

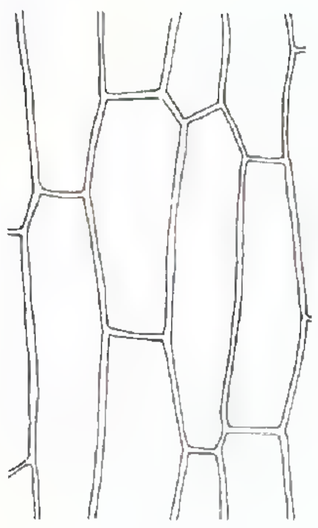
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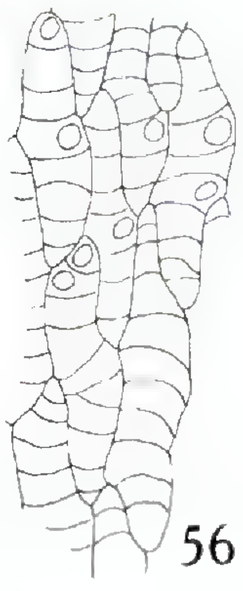
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*Sphagnum riparium*. 43. Stem cortex. 44. Stem leaves. 45. Cells at apex of stem leaf. 46. Branch cortex. 47. Branch leaves. 48. Cross-section of branch leaf. 49. Cells of branch leaf, inner surface. 50. Cells of branch leaf, outer surface.

*Sphagnum recurvum*. 51. Stem cortex. 52. Stem leaves. 53. Branch cortex. 54. Branch leaves. 55. Cross-section of branch leaf. 56. Cells of branch leaf, inner surface. 57. Cells of branch leaf, outer surface.

10. **Sphagnum recurvum** P.-Beauv., *sensu lato*—Plants usually rather robust, bright-green or (more commonly) tinged with yellow or brown. Stems often reddish toward the tip; wood cylinder yellow-green; cortical cells of stem not or only slightly differentiated, without fibrils or pores. Stem leaves very small, triangular to oblong-triangular, the border poorly developed or occupying nearly the width of the base; hyaline cells not divided, without fibrils or pores (or rarely with traces of fibrils). Branches in fascicles of 5 (2 spreading) with cortical cells in 1 layer, the retort cells with an inconspicuous neck. Branch leaves undulate and spreading at the tips when

dry, lanceolate, somewhat channeled toward the toothed apex, bordered by linear cells, entire; hyaline cells slightly convex on the inner surface, and on the inner surface with 4-7 large, round pores in the angles and near the commissures (sometimes visible only on strong staining), on the outer surface with end pores throughout and in the apical portion with 2-6 small, ringed pores also in the angles and near the commissures; in section, green cells isosceles-triangular with the base exposed on the outer surface of the leaf, its apex reaching the inner surface or nearly so. Dioicous. Spores 24-27 $\mu$, finely-roughened to nearly smooth.—n = 19+?, 19+2, 19+4.

Breen, Mosses of Florida, Pl. 128 (fig.8-14). Darlington, Mosses of Michigan, fig. 12A, 12B (as var. *tenue*). Jennings, Mosses of Western Pennsylvania, (ed. 1), Pl. 2, Pl. 3 (as *S. parvifolium*), (ed. 2) Pl. 3, Pl. 6 (as var. *tenue*). Welch, Mosses of Indiana, fig. 14.—**Fig. 51-57.**

Very common, usually in mesotrophic habitats, especially in the hollows of open *Chamaedaphne* mats or *Vaccinium* heaths or in the transition between bog and bog forest. Greenland, Newfoundland, Alaska, south to California, Colorado, Nebraska, Missouri, and the Gulf of Mexico; Panama; South America; Europe and Asia.

CHEBOYGAN CO.—Reeses Bog, Iron Bridge (Carp Creek), Gleasons Bog, Bryants Bog, Nichols Bog, Maple River, Livingston Bog, Gates Bog, Vincent Lake, Mud Lake, Grass Bay, Little Lake 16, Pine Grove State Forest Campground, Weber Lake. EMMET CO.—Near Levering, between Levering and Carp Lake, Galloway Bog, Stutsmanville, Carp Lake, Conway Bog, Wycamp Lake, Big Stone Bay. MACKINAC CO.—Bois Blanc Island, Mud Lake, Cranberry Lake, Rexton Lake, Hendricks, Little Dollar Lake, McNamara Pond, Peggley Lake, Hiawatha Sport Club. PRESQUE ISLE CO.—Loon Lake, Hammond Bay.

Locally very common and easy to recognize (in a broad sense) in a dry condition because of soft, nearly flat, broadly pointed leaves recurved at the tips and undulate at the margins. The leaves are concave and spirally ranked when moist. The young pendent branches visible in pairs between the rays of the capitulum are useful in distinguishing *S. recurvum* and its relatives (*S. pulchrum* and *S. riparium*) from members of the ACUTIFOLIA. Other useful characters include the poorly differentiated cortex, relatively small stem leaves, and the brown-tinged antheridial "catkins."

The name *recurvum* may be in question. The Europeans have tended to shun it, because it is American and, from their point of view, geographically unlikely. Shunning the oldest name without explaining its relationship to the complex is scarcely a satisfactory solution. I prefer to follow Andrews, knowing that his judgment was invariably good (although his concepts were over-inclusive).

Our Michigan material falls into three categories, as follows:

Var. **recurvum** [*S. apiculatum* H. Lindb., *S. fallax* (Klinggr.) Klinggr., *S. mucronatum* (Russ.) Zick.]—Plants of medium size, usually yellowish or brownish. Stems not red-tinged. Stem leaves small (ca. 0.8-1 mm. long), about as broad as long, deltoid, rather sharply pointed, broadly bordered at base. Branch leaves not distinctly in rows, the hyaline cells on the outer surface with rounded pores at the upper ends (and sometimes with smaller pores in the corners) and on the inner surface with rounded end and corner pores (often visible only on strong staining).

Var. **tenue** Klinggr. [*S. angustifolium* (Russ.) C. Jens., *S. parvifolium* (Warnst.) Warnst.]—Plants relatively slender, usually brownish or yellowish. Stems sometimes red-tinged. Stem leaves ca. 1 mm. long (as broad as long), ± deltoid, broadly pointed or bluntly obtuse, concave at the tip, not strongly bordered at base. Branch leaves on the outer surface with few end and corner pores, on the inner surface with numerous end and corner pores.—n = 19+4-5.

Andrews' characterization of the var. *tenue* as slender plants with small capitula and smaller, not or scarcely undulate branch leaves does not work out convincingly.

Var. **amblyphyllum** (Russ.) Warnst.—Plants relatively stout, pale green or yellow. Stems without red tinges. Stem leaves oblong- or ovate-deltoid, usually somewhat longer than broad (ca. 1-1.2 × 1 mm.), somewhat to considerably eroded because of extensive resorption at the broad, rounded, flat apex; border not sharply differentiated at base. Branch leaves 5-ranked when moist, with margins reflexed when dry.

This variety can be confused with *S. pulchrum* because of its relatively large size with branch leaves (especially in the capitulum) somewhat spirally ranked when moist and leaf margins more or less reflexed.

The scarcity of pores in the leaves of *S. recurvum* and related species makes them less absorbent, and hence during the First World War they were little used in the production of surgical dressings. Some of the INOPHLOEA, especially *S. papillosum,* were prized because of numerous large pores in the branch leaves and also in the greatly differentiated cortex. Nichols (Bryol. 21: 53-56. 1918) reported that good *Sphagnum* pads could absorb 16-22 times their weight as compared with an absorption of 5-6 times by cotton pads.

The use of *Sphagnum* in surgical dressings has an incidental advantage because of a built-in antibiotic property. *Sphagnum* is by nature somewhat antiseptic. This property, plus acidity and anaerobic conditions, make possible the accumulation of peat. Mosses in general have few parasites, either plant or animal, and for that reason require no special protection in the herbarium. McCleary and Walkington (Rev. Bryol. et Lichén. 34: 309-314. 1966) tested extracts from 50 species in 33 genera of mosses and found that 18 species show strong antibiotic properties. The antibiotically active mosses were found in the genera *Sphagnum, Dicranum, Mnium, Atrichum,* and *Polytrichum.*

Mägdefrau (Zeitsch. Bot. 29: 337-375. 1935) established the fact that in mosses both external conduction by capillarity and internal conduction through the central strand are important. He found that at 90% relative humidity internal conduction alone suffices to maintain turgor, but at lower humidities both types of conduction are necessary. He also (Ann. Bryol. 10: 146. 1938) compared the effectiveness of internal and external conduction in various mosses (in grams/0.2 grams dry weight in 24 hours at 70% relative humidity):

| | Total conduction | Internal conduction |
|---|---|---|
| *Sphagnum recurvum* | 6.54 | 0.07 |
| *Mnium undulatum* | 2.22 | 1.13 |
| *Thamnium alopecurum* | 0.019 | 0.007 |
| *Drepanocladus vernicosus* | 22.73 | 0.79 |
| *Rhytidiadelphus triquetrus* | 1.67 | 0.11 |
| *Polytrichum commune* | 3.32 | 2.24 |

Mägdefrau also showed an unmistakable relationship of growth form to conduction. Very likely the denser tufts of *Drepanocladus vernicosus* account for greater conduction. In *Sphagnum* only 1% of the conduction was internal, compared with 50% in *Mnium undulatum* and 66% in *Polytrichum commune.* A comparison of *S. recurvum* with some of the INOPHLOEA would be particularly informative.

The report of **S. lindbergii** Schimp. in Darlington's *Mosses of Michigan* (without collection data) must be rejected. *S. lindbergii* is a northern relative of *S. recurvum* with stem leaves lacerate across a broad apex.

11. **Sphagnum pulchrum** (Lindb. *ex* Braithw.) Warnst.—Plants rather robust, bright-green or brownish, shiny when dry. Apical bud small; young pendent branches in pairs between the rays of the capitulum. Wood cylinder yellow-brown; cortical cells

somewhat differentiated (but with thick walls) in 1-2 layers, without fibrils or pores. Stem leaves small (about 1 mm. long), triangular, concave, involute-pointed, the border occupying nearly the width of the base; hyaline cells not divided, rarely fibrillose. Branches in fascicles of 4 or 5 (2 spreading); cortical cells in 1 layer, the retort cells with conspicuous necks. Branch leaves somewhat reflexed, undulate-reflexed at the margins and somewhat lacquered in appearance when dry, 5-ranked when moist (and spirally arranged wet or dry), broadly ovate, abruptly narrowed to a rather long, broad, channeled, toothed, cuspidate point, bordered by linear cells, entire; hyaline cells somewhat convex on the inner surface, and on the inner surface with 3-6 rounded pores at the corners, on the outer surface with 2-5 small, ringed pores at ends and corners and along the commissures; in section, green cells broadly triangular, with the base exposed on the outer surface and the apex usually reaching only ½ or less the distance to the inner surface. Dioicous. Spores 25-28 $\mu$, slightly roughened [not seen.]

Darlington, Mosses of Michigan, fig. 13.–**Fig. 58-63.**

Rare; in open, wet portions of bogs, at the margins of bog lakes but not normally submerged; mesotrophic. Europe; Newfoundland to northern Ontario, south to Wisconsin, northern Michigan, and New Jersey (an Atlantic species in coastal areas of northwestern Europe, also more common along the Atlantic coast of North America).

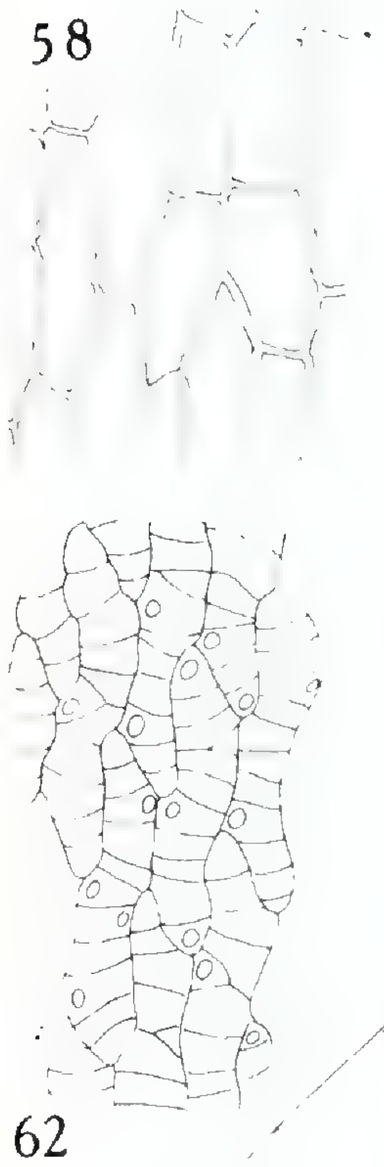
MACKINAC CO.–Rexton Lake, Little Lake.

Not always easy to distinguish from *S. recurvum* var. *amblyphyllum* but usually recognized as follows: generally robust and often brownish, with cortical cells small and thick-walled but somewhat more differentiated. Branch leaves often in five spiral ranks, broad, appearing abruptly apiculate because of involute apical margins, the margins otherwise reflexed and somewhat undulate. The green cells of the branch leaves are equilateral-triangular and do not reach the upper surface of the leaves.

12. **Sphagnum cuspidatum** Ehrh. *ex* Hoffm.–Plants weak and flexuose (especially when wet), slender to large, often very long and sometimes plumose, whitish-green to yellowish (sometimes mottled with brown because of colored antheridial branches). Apical bud small. Wood cylinder yellow-green; cortical cells of stem clearly differentiated but rather small, in 2-3 layers, without fibrils or pores. Stem leaves small, triangular-ovate, bluntly pointed, strongly concave, slightly toothed at the apex, weakly bordered; hyaline cells not divided, with or without fibrils in the apical portion. Branches generally in fascicles of 4 (2 spreading), with cortical cells in 1 layer, the retort cells with conspicuous necks. Branch leaves ± undulate and falcate when dry, narrow and long-lanceolate (about 4-5 : 1), especially long and cohering at branch tips, somewhat involute, bordered by linear cells, and entire below the toothed apex; hyaline cells slightly convex on the inner surface, and on the inner surface with few, small, and often inconspicuous pores in the ends or corners, those on the outer surface few, ± ringed, somewhat larger; in section, green cells trapezoidal with broader exposure on the outer surface. Dioicous. Spores 33-42 $\mu$, ± granulose.–n = 19+2, 19+3-4.

Breen, Mosses of Florida, Pl. 129 (fig. 1-6). Darlington, Mosses of Michigan, fig. 14. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 4.–**Fig. 64-70.**

In limp, loose masses floating in puddles of water (at least during part of the season), in relatively acid situations, at the edge of bog lakes or in drainage channels in older parts of the mat, also in depressions in boggy heaths. Newfoundland to Florida and the Great Lakes; Europe and Asia.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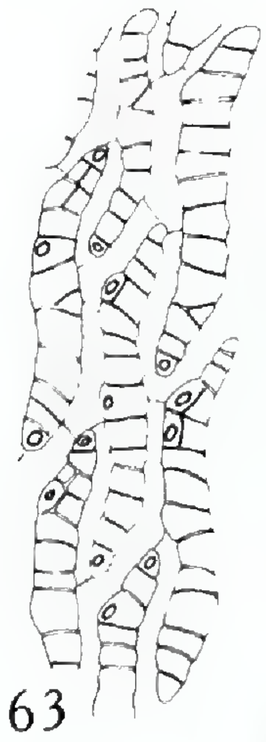
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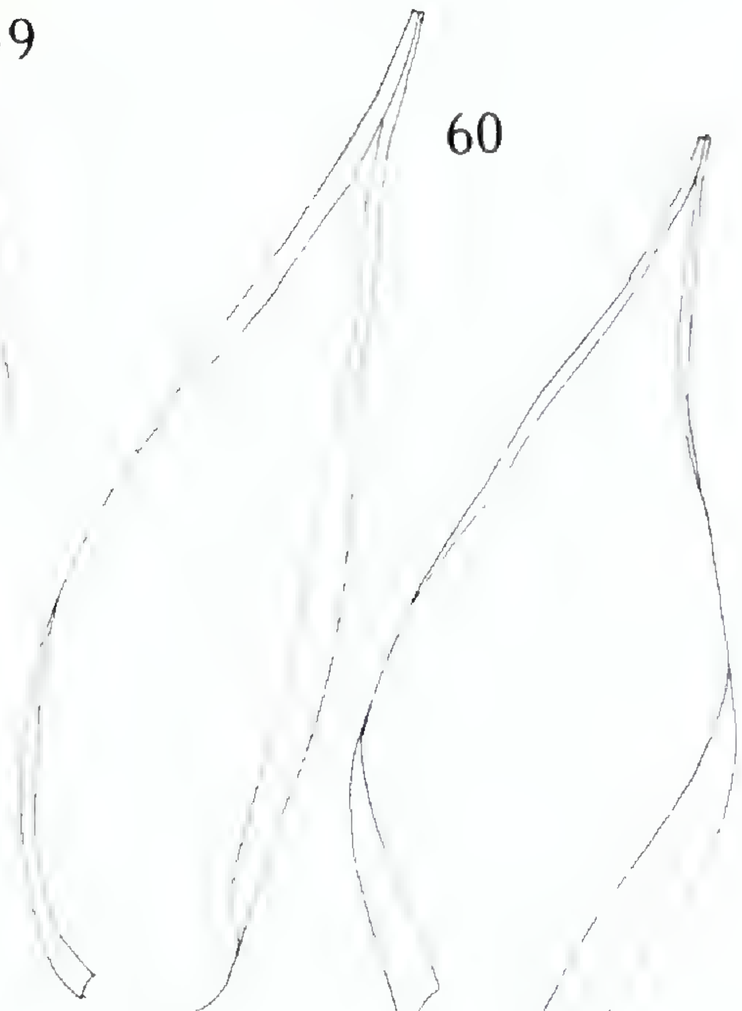
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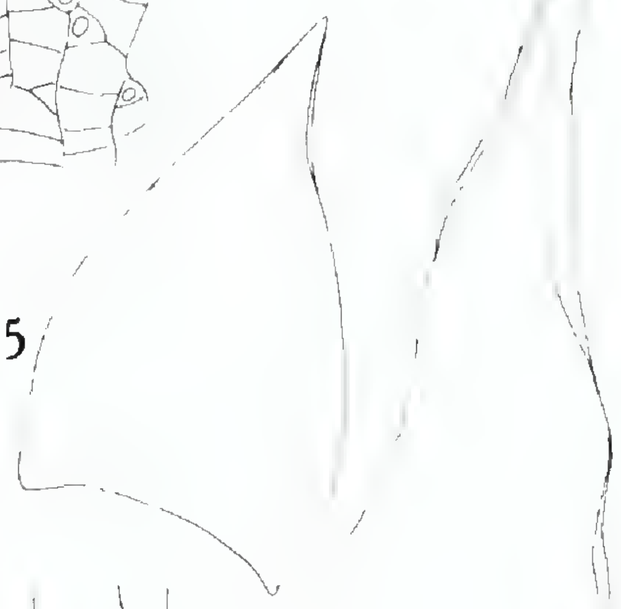
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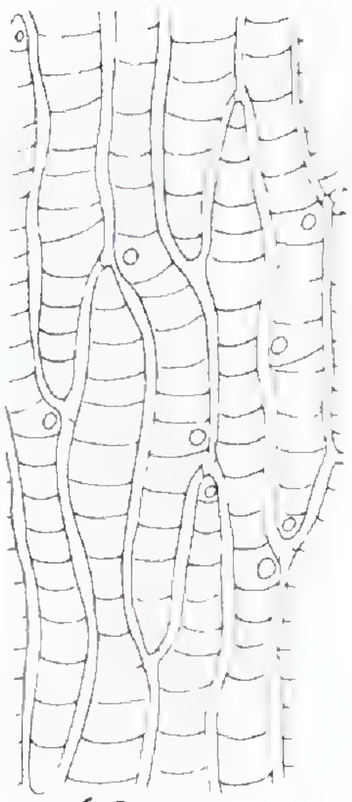
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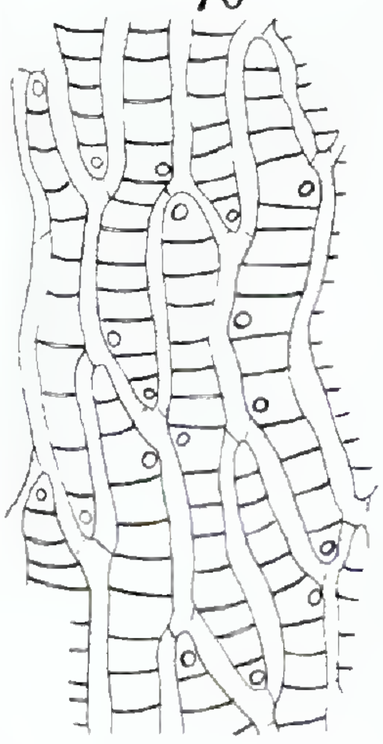
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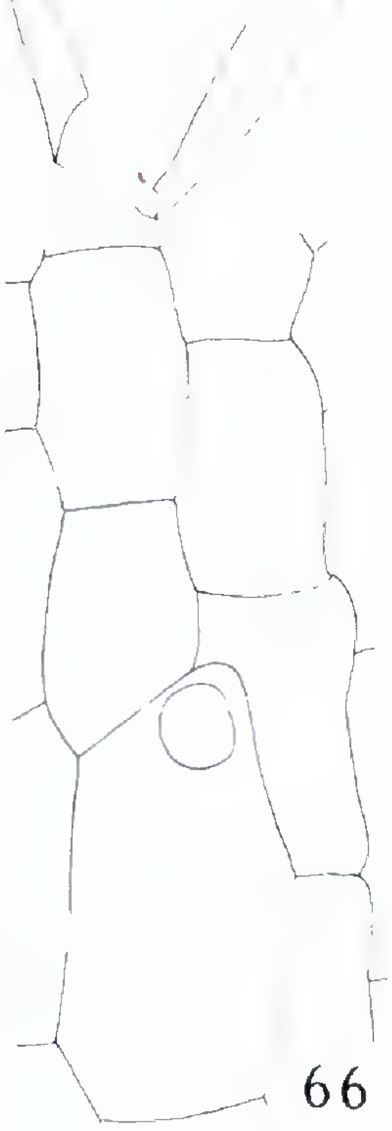
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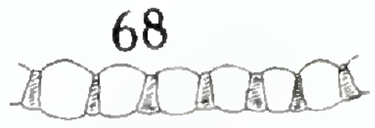
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*Sphagnum pulchrum*. 58. Stem cortex. 59. Stem leaves. 60. Branch leaves. 61. Cross-section of branch leaf. 62. Cells of branch leaf, inner surface. 63. Cells of branch leaf, outer surface.

*Sphagnum cuspidatum*. 64. Stem cortex. 65. Stem leaf. 66. Branch cortex. 67. Branch leaf. 68. Cross-section of branch leaf. 69. Cells of branch leaf, inner surface. 70. Cells of branch leaf, outer surface.

CHEBOYGAN CO.–Iron Bridge (Carp Creek), Bryants Bog, Gates Bog, Nichols Bog, Mud Lake, Topinabee, Weber Lake. EMMET CO.–Maple River, between Levering and Carp Lake, Stutsmanville, Big Stone Bay. MACKINAC CO.–Rexton Lake, Little Dollar Lake, Hendricks, Cranberry Lake. PRESQUE ISLE CO.–Loon Lake.

Plants of particularly wet habitats (usually submerged and appearing weak and limp). As compared with *S. majus*, the branch leaves are relatively long and narrow (usually about four times as long as broad) and stick together like the point of an artist's brush when drawn from the water. The pores on the outer surface of the branch leaves are few or none; those on the inner surface are more numerous (but in submerged forms sometimes entirely lacking). *S. cuspidatum* commonly grows barely submerged in shallow pools and drainage channels of open bogs. As such puddles dry out, it assumes a form that is often confused with *S. recurvum*. Typically, the branch

leaves are longer, often nearly linear, frequently without undulations, and their cells are narrow with pores only at the ends. In questionable cases, a number of characters can be used: In *S. cuspidatum,* the pendent branches are poorly differentiated and do not conceal the stems; the young pendent branches are not paired; the stem leaves are somewhat fibrillose above; the stem cortex consists of about two layers of fairly good-sized, rather thin-walled cells; and the green cells of the branch leaves are trapezoidal in section. In *S. recurvum,* the pendent branches (paired in the capitulum) are long and appressed to the stem; the stem leaves are not fibrillose above; the stem cortex is less differentiated; and the green cells of the branch leaves are triangular in section. The long-tapered branches of *S. cuspidatum* are also useful in identification.

13. **Sphagnum majus** (Russ.) C. Jens.–Plants medium-sized to large, light-brown or brownish-green (and somewhat mottled because of darker shades within the capitulum when moist), usually shiny when dry; terminal bud scarcely discernible to moderately enlarged. Wood cylinder yellow-green; cortical cells of stem poorly differentiated in 1 layer of rather small cells without fibrils or pores. Stem leaves rather small, oblong-triangular, ± concave and rounded at the apex, the border very broad and increasing in width toward the base; hyaline cells not divided, with rudimentary fibrils in the apical portion or none. Branches in fascicles of 4-5 (2 spreading), with cortical cells in 1 layer, the retort cells with inconspicuous necks. Branch leaves not or sometimes slightly undulate, usually subsecund, long, ovate-lanceolate (broader than in *S. cuspidatum*), somewhat involute-pointed, bordered by linear cells and entire; hyaline cells on the inner surface somewhat convex and with pores lacking (or occasionally with a few, larger, unringed pores restricted to corners in the apical portion of the leaf), on the outer surface with numerous, large pores often in a single ± median row (½ or more the width of the cell) and also smaller pores in the lateral corners (the median pores sometimes few or lacking); in section, green cells mostly trapezoidal with broader exposure on the outer surface. Dioicous. Spores 24-38 $\mu$, somewhat roughened to nearly smooth.–n = 38.

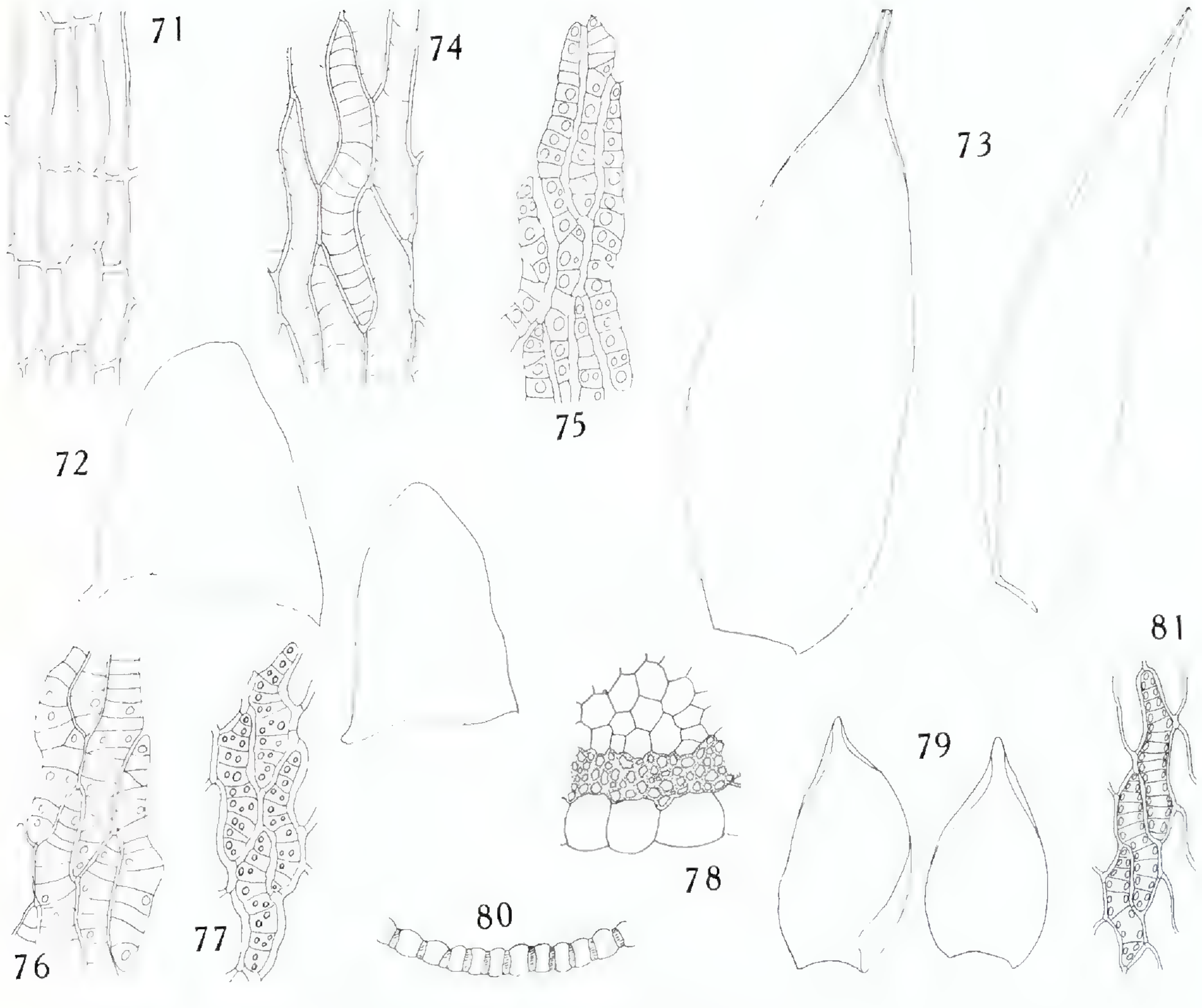
Darlington, Mosses of Michigan, fig. 15 (as *S. dusenii*). Sullivant, Icones Muscorum Supplement, Pl. 2 (as *S. cuspidatum* var.).–**Fig. 71-75.**

Submerged or emergent, in relatively eutrophic habitats, in open sedgey bogs and commonly in the moat surrounding bog mats. Labrador to Alaska and British Columbia, south to Virginia and the Great Lakes; Europe and Asia.

CHEBOYGAN CO.–Iron Bridge (Carp Creek), Livingston Bog, Gleasons Bog, Bryants Bog, Vincent Lake, Gates Bog, Nichols Bog, Mud Lake, Topinabee, Little Lake 16. EMMET CO.–Stutsmanville, Cecil Bay, Big Stone Bay, Carp Lake, between Levering and Carp Lake. MACKINAC CO.–Little Dollar Lake.

*Sphagnum majus* is best distinguished from *S. cuspidatum* by the rather large and numerous pores on the outer surface of the branch leaves (which may, unfortunately, be reduced or lacking in submerged forms). The macroscopic differences are sometimes helpful: *S. majus* is stronger, stouter, essentially erect, and nearly always brownish; when moist, it seems brownish-green mottled because of darker shading within the capitulum. The branches of the capitulum are less pointed and the branch leaves broader and not undulate. *S. annulatum* var. *porosum* has a large terminal bud and hyaline cells of branch leaves with pores on both surfaces (those on the inner surface few and exceedingly small).

14. **Sphagnum annulatum** Warnst. var. **porosum** (Schlieph. & Warnst. *ex* Warnst.) Maass & Isov. *ex* Maass–Plants medium-sized to large, green or brown, ± glossy when




*Sphagnum majus.* 71. Stem cortex. 72. Stem leaves. 73. Branch leaves. 74. Cells of branch leaf, inner surface. 75. Cells of branch leaf, outer surface.

*Sphagnum annulatum* var. *porosum.* 76. Cells of branch leaf, inner surface. 77. Cells of branch leaf, outer surface.

*Sphagnum subsecundum* var. *subsecundum.* 78. Cross-section of stem. 79. Branch leaves. 80. Cross-section of branch leaf. 81. Cells of branch leaf, outer surface.

dry, with the terminal bud large (especially prominent and noticeable when moist). Cortical cells of stem slightly enlarged, in 1-2 rows, thick-walled, without fibrils or pores. Stem leaves rather large, triangular to oblong-triangular, ± rounded and concave at the apex, becoming broadly bordered by linear cells toward the base, entire, with hyaline cells not divided, without pores, fibrillose nearly throughout the leaf. Branch leaves ± spreading at the tips and undulate at the margins when dry, often somewhat secund, about 2.3-3 mm. long, ovate, acuminate; hyaline cells with numerous rather small to medium-sized, round pores in a median row or sometimes in 2 irregular rows on the outer surface (occasionally also with a few scattered, small, ringed pores) and with few to several minute, ringed pores on some but not all cells on the inner surface (easily overlooked); in section, green cells tending to be triangular, exposed on the outer surface.

Maass, Nova Hedwigia, Pl. 69 (fig. 2), Pl. 72 (fig. 7-10), Pl. 73 (fig. 16, 18, 19), Pl. 76 (fig. 40-41).–**Fig. 76-77.**

Very rare. In very wet, open sites, and submerged or emergent, at the very margins of bog lakes or in shallow drainage channels in open bogs in moderately minerotrophic habitats. Circumpolar; in North America, known from Alaska, Mackenzie District of the Canadian Northwest, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Wyoming, and Michigan.

CHEBOYGAN CO.–Livingston Bog, Nichols Bog, Mud Lake.

Distinguished from *S. majus* by a large terminal bud and smaller pores on the outer surface of branch leaves, as well as few, scattered, minute, ringed pores on the inner surface (easily overlooked except on heavy staining). Rarely the pores may be medium-sized and unringed but in that case too numerous for *S. majus.* Also in contrast to *S. majus, S. annulatum* var. *porosum* may be found prostrate, owing to weaker stems.

d. Hyaline cells of branch leaves with numerous, small, elliptic pores arranged in a bead-like fashion along the commissures; green cells exposed equally on both surfaces or more broadly on the outer.

15. **Sphagnum subsecundum** Nees *ex* Sturm, *sensu lato*–Plants small to medium-sized, green or tinged with orange. Wood cylinder brown; cortical cells of stem in 1 layer, thin-walled, without fibrils or pores. Stem leaves small (0.1-6 mm. long), ± triangular, blunt and cucullate at the apex, the border narrow, slightly wider below; hyaline cells rarely divided, with fibrils none or only at extreme apex, with pores none or rarely few to fairly numerous on the outer surface near the apex, abundant on the inner surface. Branches in fascicles of 2-6 (2-3 spreading), the spreading ones curved, with cortical cells in 1 layer, without fibrils, the retort cells with inconspicuous necks. Branch leaves ± curved-secund, not undulate, small (1.1-1.4 mm. long), normally ovate (but varying from lanceolate to suborbicular), generally involute to the toothed apex, the border of linear cells, entire; hyaline cells only slightly convex (somewhat more so on the inner surface), on the inner surface with few or no pores on the outer surface numerous, in rows like a string of beads along the commissures, elliptic, strongly ringed (sometimes pseudopores); in section, green cells truncately elliptic with equal exposure to trapezoidal with broader exposure on the outer surface (and sometimes nearly included on the inner surface). Dioicous. Spores 33-36 $\mu$, finely granulose.–n = 19+2, 19+7.

Breen, Mosses of Florida, Pl. 130 (figs. 8-15). Darlington, Mosses of Michigan, fig. 16. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 4 & 5 (as *S. platyphyllum, S. auriculatum, S. subsecundum, S. inundatum* var. *auriculatum,* and *S. pungens*), (ed. 2) Pl. 5 (as *S. platyphyllum* and *S. auriculatum*), Pl. 9, 10 (as *S. inundatum* var. *auriculatum*). Welch, Mosses of Indiana, fig. 16.–**Fig. 78-81.**

In minerotrophic habitats, in burned-over, sedgey bogs, wet sedge meadows, and floating mats, often at the edge of water or in the moat surrounding bogs, commonly in very wet or even submerged sites. Greenland; Labrador to Saskatchewan and Montana, south to the Gulf of Mexico; Washington to California; Costa Rica; Europe and Asia.

The outstanding character of this species complex is the bead-like arrangement of pores along the margins of the hyaline cells of the branch leaves (and sometimes also the stem leaves). A number of segregates can be recognized locally:

Var. **subsecundum**.–Plants usually yellowish to orange-brown, shiny when dry, with a scarcely discernible terminal bud and branches of the capitulum irregularly curved because of curved-secund leaves; cortical cells of stem in 1 layer; stem leaves about 1 mm. long and shorter than branch leaves, oblong-triangular, blunt and cucullate, with fibrils and pores only near the apex.–Livingston Bog, Gleasons Bog, Nichols Bog, Gates Bog, Vincent Lake, Topinabee, Little Lake 16 and Weber Lake in Cheboygan County; Galloway Lake, Carp Lake and between Levering and Carp Lake, and Wilderness State Park in Emmet County; Peggley Lake, Little Dollar Lake, Rexton Lake, Hiawatha Sports Club, and Cranberry Lake in Mackinac County.

Var. **contortum** (Schultz) Hüb.–Terminal bud small; branches of capitulum curved; cortical cells of stems in 2-3 layers; stem leaves oblong-triangular, 1-1.6 mm. long and shorter than branch leaves, with few pores on the outer surface of hyaline cells, numerous on the inner; branch leaves 1.3-2 mm. long, not particularly crowded, rather indistinctly curved-secund when dry.–Bois Blanc Island, Peggley Lake, and Ryerse Lake in Mackinac County and Dow Lake in Emmet County.

Var. **platyphyllum** (Lindb. *ex* Braithw.) Card.–Plants large and coarse (especially when wet), with limp stems, a large terminal bud, and 1-3 fat sausage-like branches at each fascicle (or nearly simple); capitulum scarcely differentiated and not star-shaped; pendent branches poorly differentiated and not concealing the stem; cortical cells of stem 2-4-layered; stem leaves oblong, 1.5-3 mm. long and similar to branch leaves in shape, size, and structure, or larger, with hyaline cells fibrillose and porose throughout, with many pores on the outer surface and rather few pores on the inner; branch leaves about 2-2.5 mm. long, loosely erect and dull on drying.–Weber Lake, Topinabee, and Nichols Bog in Cheboygan County and Dow Lake in Emmet County.

Var. **rufescens** (Nees, Hornsch. & Sturm) Hüb. (*S. auriculatum* Schimp.)–Plants sometimes rather robust, with a small terminal bud and pendent branches obscuring the stems; cortical cells of stem 1-layered; stem leaves oblong, 1.2-2.0 mm. long, more than ½ as long as the branch leaves, concave, with hyaline cells fibrillose in the upper ½ or more (often nearly throughout), with pores many on the outer surface, rather numerous on the inner.–n = 38+4.–Found in nearby Chippewa County and at Little Lake 16 and Livingston Bog, Cheboygan County.

Var. **inundatum** (Russ.) C. Jens.–Cortical cells of stem in 1 layer (or irregularly 2-layered); stem leaves oblong-triangular, 0.8-1.4 mm. long, only about ½ as long as the branch leaves, with hyaline cells fibrillose in the upper ½, with pores none or few on the outer surface, many on the inner.–n = 38+2+, ca. 42.–Found nearby in Chippewa and Antrim Counties.

Andrews' inclusive view of the species was perhaps overdone, as is the recent tendency to recognize a number of technical species in spite of intergradation. In view of several studies showing that the variations in the SUBSECUNDA are particularly influenced by fluctuations in habitat, such as seasonal flooding, I prefer to segregate varieties rather than species. Significant ecological variations have been related to various taxonomic units by Åberg (Ark. Bot. 29A(1): 1-78. 1937), Jelenc (Rev. Bryol. et Lichén. 37: 17-32. 1970), and Mägdefrau & Winkler (Zeitschr. Wiss. Pfl.-physiol. 54: 174-182. 1966). Rahman (Jour. Bryol. 7: 169-179. 1973) used methods of numerical taxonomy in defining variants in Great Britain. Jensen (Bot. Tidsskr. 13: 199-210. 1883; translated by Gravet, Rev. Bryol. 14: 33-42. 1887) analyzed the kinds of variations which recur in various unrelated species of *Sphagnum* and attributed such analogous forms to environmental factors, such as moisture, less commonly light, and occasionally temperature:

1. Fo. *immersae*. Submerged plants characterized by long stems, poorly marked capitula, widely spaced branch tufts with branches ± uniform and not corticating the stem, long stem leaves approaching the branch leaves in form and structure, long, less imbricate branch leaves, and fruiting branches considerably elongated and originating at intervals fairly remote from the stem tip.
2. Fo. *compactae et strictae*. Plants of cold or dry habitats, growing in low, compact tufts with short, erect branches and imbricated leaves.
3. Fo. *squarrosulae*. Shade forms with robust stems and bright-green leaves with squarrose-spreading tips; the fruiting branches become somewhat elongated and occur at intervals well below the stem tip.

4. Fo. *homophyllae.* Plants of dry (or sometimes aquatic) habitats in which the stem leaves develop a form and structure similar to that of the branch leaves.
5. Fo. *laxae.* Plants with widely spaced leaves.
6. Fo. *tenellae.* Plants of slender habit.
7. Fo. *falcatae.* Plants with curved branches (especially at the stem tips) and correspondingly curved-secund leaves.

All these expressions can be demonstrated especially well in the *Sphagnum subsecundum* complex. Isophylly (see 4, above) is common here and, for example, in the complex centered around *S. capillaceum.*

e. Plants often red; stem leaves with resorption mostly on the upper surface; perichaetial leaves mostly without resorption on either surface; green cells of branch leaves with exclusive or greater exposure on the inner surface.*

16. **Sphagnum fimbriatum** Wils. *ex* J. D. Hook. & Wils.–Plants slender and rather flexuose, pale, green or yellowish, with a very large, conic terminal bud. Wood cylinder green; cortical cells of stem in 1-3 layers, thin-walled, without fibrils, the outer cells with a single large pore in the upper end. Stem leaves broadly spatulate, lacerate-fringed at the broad apex and along the sides because of extensive resorption, with a triangular area of resorption at the middle of the base; hyaline cells divided 1 or more times, without fibrils, resorbed almost entirely on both surfaces. Branches usually in fascicles of 5 (2-3 spreading), with cortical cells in 1 layer, without fibrils, the retort cells with inconspicuous necks. Branch leaves imbricate, small, narrowly ovate, involute-concave, bordered by linear cells, entire except at the toothed apex; hyaline cells convex, especially on the outer surface, on the inner surface with 4-6 large, round pores nearly as wide as the cell, on the outer surface with more numerous, smaller, elliptic pores near the commissures, strongly ringed in the upper half of the leaf; in section, green cells trapezoidal with slightly broader exposure on the inner surface. Monoicous. Spores 20-26 $\mu$, nearly smooth to finely roughened.–n = 19+2, 19+4, 19+6-7, 38+4.

Darlington, Mosses of Michigan, fig. 17. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 3, (ed. 2) Pl. 6. Welch, Mosses of Indiana, Fig. 17.–**Fig. 82-88.**

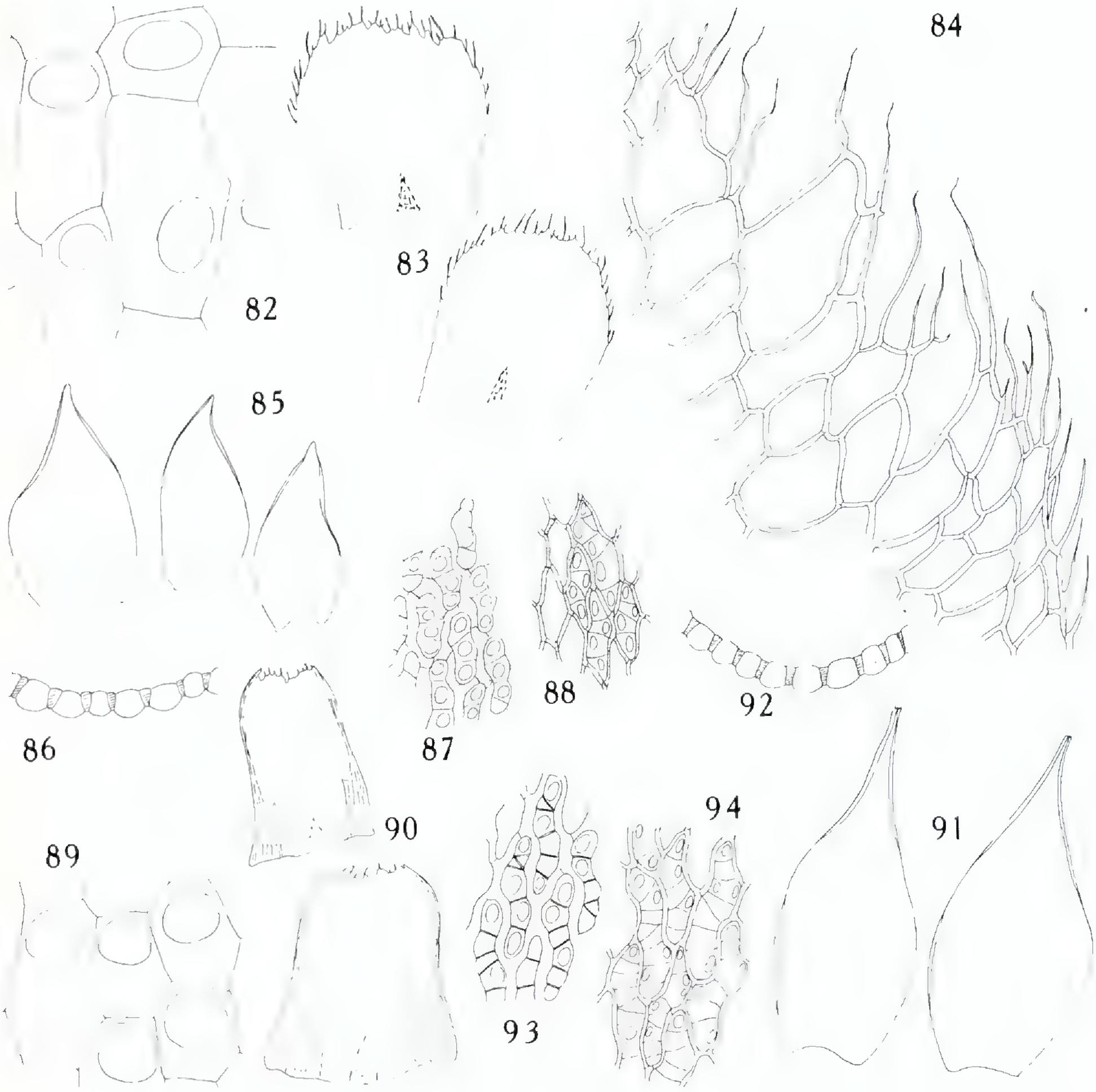
In relatively dry places in the open (in Chamaedaphne bogs) or in the brushy transition between bog and forest, in low hummocks supported by the bases of *Chamaedaphne* bushes; relatively mesotrophic. Greenland; Labrador to Alaska, south to Maryland, the Great Lakes, Missouri, and California; South America; Europe and Asia.

CHEBOYGAN CO.–Reeses Bog, Mud Lake, Grass Bay, Little Lake 16. EMMET CO.–Between Levering and Carp Lake, Larks Lake. MACKINAC CO.–Rexton Lake.

The plants, slender and bright-green when moist, are grayish when dry, and the large terminal bud is grayish-cobwebby because of extensive fringing of the leaves enveloping it. The branches of the capitulum are slender and the spreading branches below the capitulum long and stringy. As in *S. girgensohnii* and *S. russowii,* the cortical cells of the stem are porose. The stem leaves are conspicuously fringed-lacerate at both sides and apex and therefore bordered only at the basal corners. The plants commonly fruit. (In arctic tundra, plants may be smaller, more compact, and tinged with brown.)

17. **Sphagnum girgensohnii** Russ.–Plants usually fairly robust, green or sometimes slightly yellowish or brownish (not at all reddish). Stems woody but flexuose; terminal bud moderately large. Wood cylinder green to brown, not at all reddish;

*See also *S. quinquefarium,* p. 364.




*Sphagnum fimbriatum.* 82. Stem cortex. 83. Stem leaves. 84. Cells at apex of stem leaf. 85. Branch leaves. 86. Cross-section of branch leaf. 87. Cells of branch leaf, inner surface. 88. Cells of branch leaf, outer surface.

*Sphagnum girgensohnii.* 89. Stem cortex. 90. Stem leaves. 91. Branch leaves. 92. Cross-section of branch leaf. 93. Cells of branch leaf, inner surface. 94. Cells of branch leaf, outer surface.

cortical cells in 2-4 layers, isodiametric, thin-walled, without fibrils, the outer cells with a single, large, round pore. Stem leaves large, broadly lingulate, slightly concave, shortly lacerate at the broadly truncate apex, with a strong border broadened toward the base; mid-basal cells greatly resorbed in a triangular, sieve-like area; hyaline cells not divided (or a few near the upper margins often divided), without fibrils (except in hemi-isophyllous forms), greatly resorbed on both surfaces. Branches in fascicles of 4-5 (2 spreading), with cortical cells in 1 layer, without fibrils, the retort cells with conspicuous necks. Branch leaves imbricate or rarely ± squarrose, mostly small, narrowly ovate, involute, bordered by linear cells, entire except at the apex; hyaline cells not or slightly convex on the inner surface, decidedly so on the outer, on the inner surface with 3-5 large, rounded pores, on the outer surface with 4-12 elliptic pores along the commissures; in section the green cells trapezoidal to triangular with broader exposure on the inner surface. Dioicous (and rarely also monoicous). Spores 18-24 $\mu$, very finely papillose.—n = 19+2, 19+4.

Darlington, Mosses of Michigan, fig. 18. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 7. Welch, Mosses of Indiana, fig. 18. Sullivant, Icones Muscorum Supplement, Pl. 5.–**Fig. 89-94.**

In shade in bog forests or *Thuja* swamps; eutrophic to mesotrophic. Greenland; Labrador through the Great Lakes and south to North Carolina and Tennessee; Alaska to Oregon, Idaho and Montana; Europe and Asia.

CHEBOYGAN CO.–Hermits Bog, Reeses Bog, Gorge of Carp Creek, Iron Bridge (on Carp Creek), Bryants Bog, Livingston Bog, Mud Lake, Gates Bog, Grass Bay, Grass Lake. EMMET CO.–Conway Bog, Stutsmanville, Wycamp Lake, Wilderness State Park. MACKINAC CO.–Hiawatha Sports Club, Hog Island Forest Campground, Prentiss Bay, Epoufette, Rexton, Garnet, Little Dollar Lake, Hendricks, McNamara Pond. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach.

The capitulum is conspicuously star-shaped because the spreading branches are usually long and drooping in five rows. The stem leaves are moderately fringed across the broad apex but entire and bordered along the sides. A triangular sieve-like area of large, open, resorbed cells at the middle of the base of stem leaves is a striking feature of the species and its relative, *S. fimbriatum.*

*Cryptothallus mirabilis* Malmb., a saprophytic liverwort of northern and western Europe, should be sought in our area. It grows in woodlands in moist, acid litter, covered by bryophytes, of which species of *Sphagnum* are most prominent. In Norway it is most often associated with *Sphagnum girgensohnii,* whereas in Great Britain it favors *S. fimbriatum, S. palustre,* and *S. recurvum.* It has also been found in the absence of *Sphagnum,* under other bryophytes such as *Pellia epiphylla,* for example. It has an endotrophic mycorrhizal relationship similar to that known for *Riccardia pinguis,* which it greatly resembles except in its yellow-white color. The mycorrhizal relationship is apparently shared by *Betula* (see Williams, Trans. Brit. Bryol. Soc. 5: 357-366. 1950, and Dickson & Holman, Blyttia 26: 8-10. 1968).

18. **Sphagnum russowii** Warnst.–Plants slender to moderately robust, green or mottled-red. Terminal bud small to moderate in size. Wood cylinder green; cortical cells of stem in 2-4 layers, thin-walled, without fibrils, the outer cells mostly with a single, rather large, rounded pore near the upper end. Stem leaves rather large, oblong-lingulate (usually noticeably enlarged toward the apex), nearly flat or sometimes slightly concave above, slightly (and often inconspicuously) erose at the middle of a broad, ± rounded apex, the border often much broadened near the base; hyaline cells mostly undivided (but some are divided in each leaf), often with traces of fibrils, nearly all resorbed on the inner surface, mostly with membrane pleats (only rarely with a few pores and considerable development of fibrils). Branches in fascicles of 4-5 (2 spreading), with cortical cells in a single layer, without fibrils, the retort cells with conspicuous necks. Branch leaves imbricate, small, ovate-lanceolate, involute, bordered by linear cells and entire except at the apex; hyaline cells very slightly convex on the inner surface, more so on the outer, on the inner surface with 3-6 large pores nearly as wide as the cells, on the outer surface with 4-8 elliptic pores along the commissures; in section the green cells triangular with the base exposed on the inner surface, the apex reaching the inner surface. Dioicous or monoicous. Spores 20-26 $\mu$, finely granulose.–n = 19+5-11, 38+4, 38+5-11, 38+8.

Darlington, Mosses of Michigan, fig. 19 (as *S. robustum*).–**Fig. 95-101.**

Very common in hummocks in open bogs and in the marginal forests; oligotrophic. Greenland; Labrador to the Great Lakes and New York; North Carolina; western United States; Europe and Asia.

CHEBOYGAN CO.–Reeses Bog, Gorge of Carp Creek, Iron Bridge (Carp Creek), Gates Bog, Mud Lake, Livingston Bog, Little Lake 16, Grass Lake. EMMET CO.–Antique Bog, Stutsmanville,

Carp Lake, between Levering and Carp Lake. MACKINAC CO.–Bois Blanc Island, Epoufette, Rexton Lake, Little Dollar Lake, Scotty Bay, Prentiss Bay, McNamara Pond, Hendricks, Hog Island Forest Campground, Hiawatha Sports Club. PRESQUE ISLE CO.–Evergreen Beach, Hammond Bay.

*Sphagnum russowii* is only medium-sized. The name *robustum* often applied to the species is inappropriate and, fortunately, nomenclaturally unacceptable. In contrast to *S. fimbriatum* and *S. girgensohnii,* which also have porose cells of the stem cortex, *S. russowii* has only an inconspicuous terminal bud. The plants are often red-mottled; even in green shade forms, red tinges can be found in streaks on the stem near the capitulum or in leaves protecting the antheridia on male branches. The young spreading branches of the capitulum are relatively coarse and ± clavate. The broad, lingulate stem leaves are slightly fringed at the middle of the apex but by no means approach the laceration of *S. girgensohnii.* Confusion is much more likely with *S. capillaceum* var. *tenellum,* which, of course, lacks pores in the stem cortex. It should be noted that the pores are occasionally hard to demonstrate. In such cases it is helpful to remember that the stem leaves of *S. russowii* have only few hyaline cells divided, whereas most of them are divided in *S. capillaceum* var. *tenellum.*

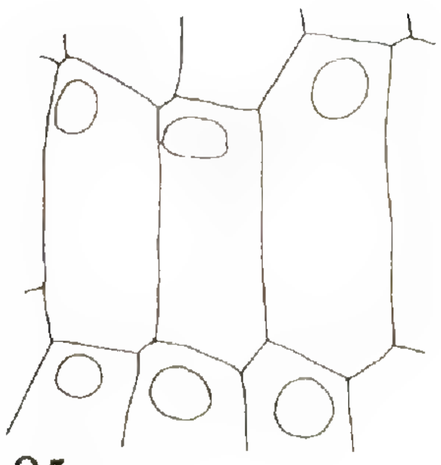
19. **Sphagnum warnstorfii** Russ.–Plants slender and delicate, green or red. Wood cylinder usually reddish (sometimes brown); cortical cells of stem in 2-4 layers, thin-walled, without fibrils, the outer cells without pores. Stem leaves of medium size, oblong-lingulate, slightly concave, the border strong, somewhat to strongly broadened near the base; hyaline cells mostly 1-, rarely 2-divided without fibrils (or rarely with a few vestigial fibrils), mostly resorbed on the inner surface, with membrane pleats. Branches in fascicles of 3-5 (2 spreading), with cortical cells in 1 layer, without fibrils, the retort cells with conspicuous necks. Branch leaves usually in 5 spiral ranks, slightly recurved and often ± secund at the tips when dry, small, lanceolate, involute, bordered by linear cells; hyaline cells slightly convex on the inner surface, much more so on the outer, on the inner surface with 2-6 pores at the ends and sometimes also at the side corners, on the outer surface in the upper ½ with 2-8 very small, strongly ringed, rounded or ± elliptic pores mostly near the commissures; in section, the green cells triangular or trapezoidal with broader exposure on the inner surface. Dioicous. Spores 17-20 $\mu$, finely papillose.–n = 19+2, 19+2-4, 19+4.

Breen, Mosses of Florida, Pl. 132 (fig. 1-7). Darlington, Mosses of Michigan, fig. 21. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 3 & (ed. 2) Pl. 6 (as *S. warnstorfii* var. *virescens*).–Fig. 102-107.

A calciphile, common in open, rich fens and in bog forests (such as *Thuja* swamps). Greenland; Labrador to Alaska, south to the Great Lakes and Colorado; Florida; Europe and Asia.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Iron Bridge (Carp Creek), Livingston Bog, Blanchard Lake, Mud Lake, Indian River, Hebron Swamp, Pine Grove State Forest Campground, Little Lake 16, Grass Lake. EMMET CO.–Galloway Bog, Pleasantview Swamp, Wycamp Lake, Cecil Bay, Bear Creek Township, Conway Bog, Ramona Beach. MACKINAC CO.–Mud Lake, McNamara Pond, Rexton, Hiawatha Sports Club. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Presque Isle Corporation, Clinton Lake.

The plants are generally red or even purplish. Even in green shade forms, the red branch axis can be seen showing through the leaves. The branch leaves, arranged in five distinct rows, curved outward when dry. The exceedingly small, rounded, and strongly ringed pores are discernible only as pepper-dots under the low power of a microscope.



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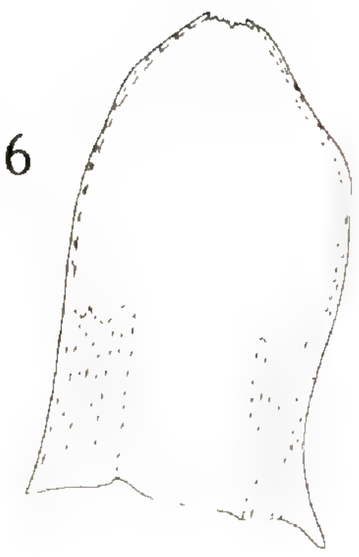

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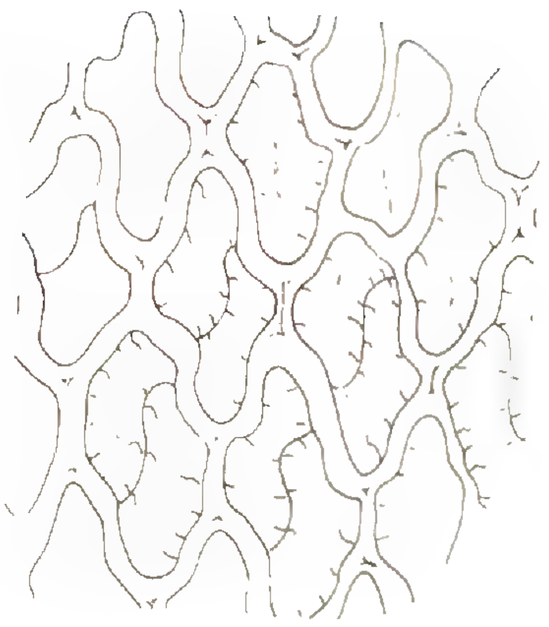

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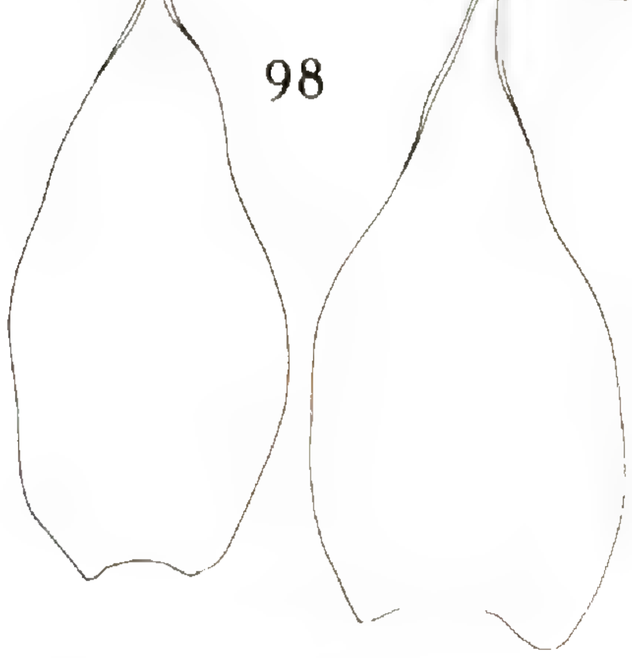

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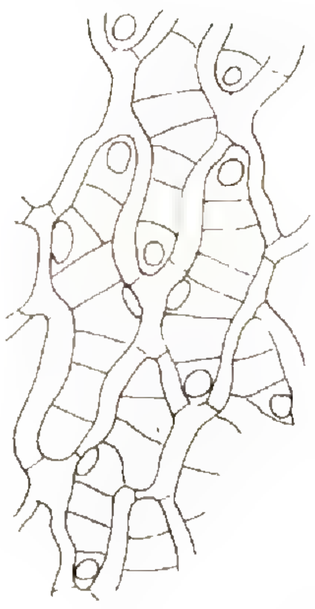

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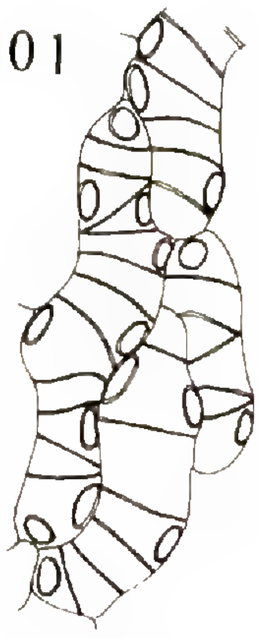

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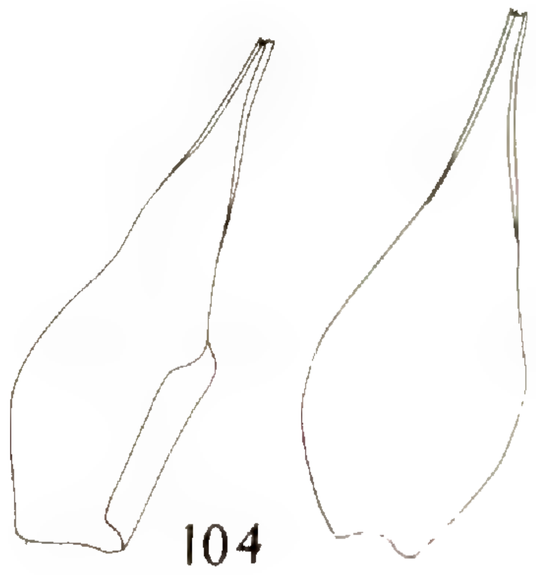

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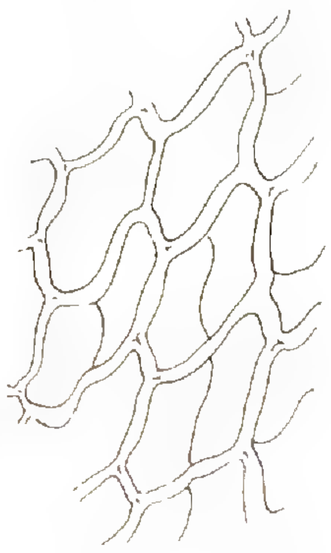

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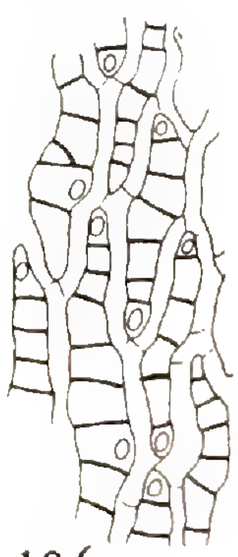

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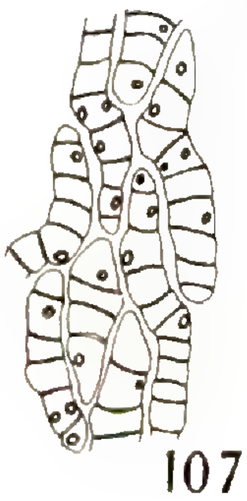

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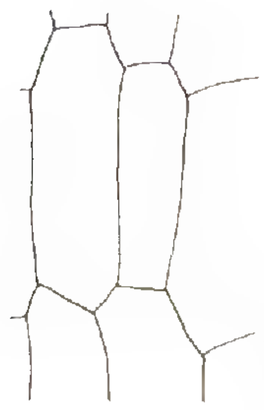

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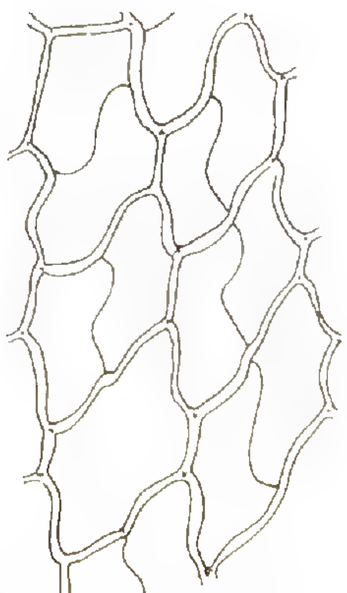

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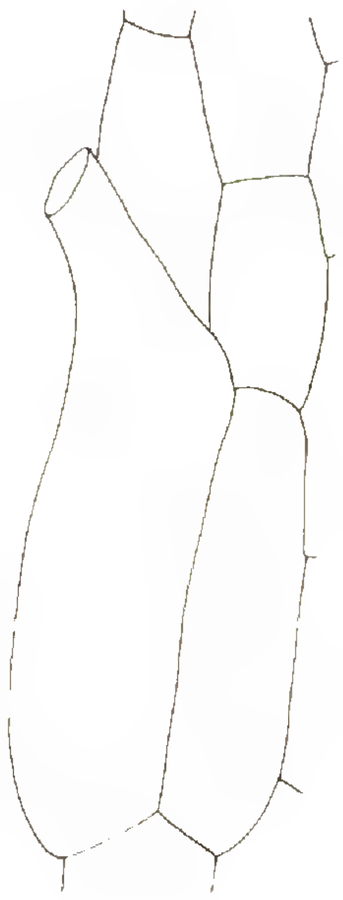

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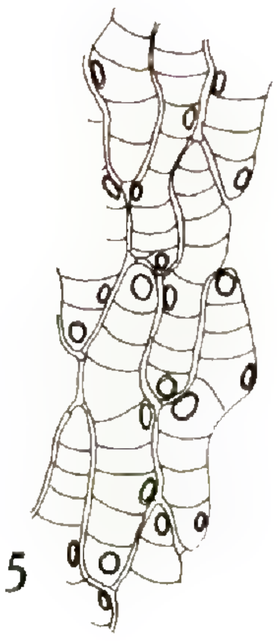

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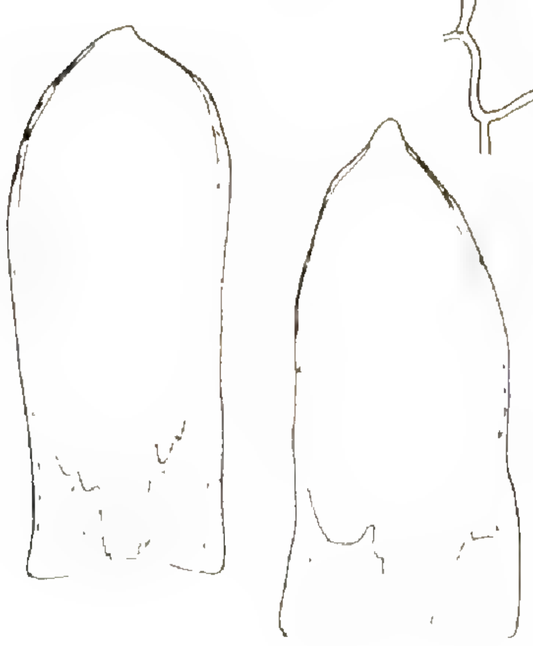

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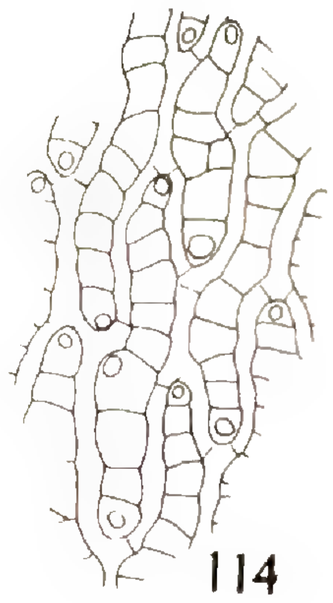

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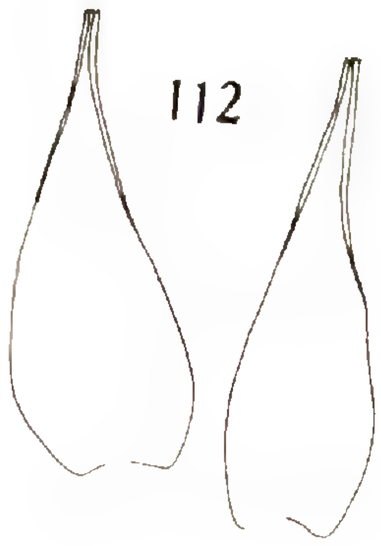


20. **Sphagnum fuscum** (Schimp.) Klinggr.–Plants usually slender and delicate, in very compact hummocks, usually brown (but occasionally, in shade, merely tinged with brown or completely green). Wood cylinder brown; cortical cells of stem thin-walled, without fibrils, the outer cells without pores. Stem leaves medium-sized, lingulate, slightly concave, with a strong border, strongly broadened near the base; hyaline cells mostly 1-, sometimes 2-divided, without fibrils, nearly resorbed on the inner surface. Branches slender and thread-like, in fascicles of 3-5 (2 normally spreading), with cortical cells in 1 layer, without fibrils, the retort cells with conspicuous necks. Branch leaves imbricate or with somewhat spreading tips, small, lanceolate, involute, bordered by linear cells and entire except at the toothed apex; hyaline cells not or slightly convex on the inner surface, strongly so on the outer, on the inner surface with pores at the ends and sometimes also in the side corners (2-4 per cell), on the outer surface with 3-8 small, elliptic pores near the commissures in the apical part of the leaf, increasing in size toward the base; in section the green cells triangular or rarely trapezoidal with broader exposure on the inner surface. Dioicous. Spores 20-24 $\mu$, finely papillose or nearly smooth.–n = 19+2, 19+3-4, 19+4.

Darlington, Mosses of Michigan, fig. 20. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 8.–**Fig. 108-115.**

Capping hummocks in older, drier, more acid parts of open bogs; distinctly oligotrophic. Greenland; Labrador to Alaska, south to Virginia; the Great Lakes area, Colorado, and Washington; Europe and Asia.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge (Carp Creek), Gleasons Bog, Livingston Bog, Nichols Bog, Mud Lake, Little Lake 16, Weber Lake, Grass Lake, Pine Grove State Forest Campground. EMMET CO.–West of Pellston, Stutsmanville, Galloway Bog, Conway Bog, Bear Creek Township, Cecil Bay, Wilderness State Park. MACKINAC CO.–Prentiss Bay, Hessel, Mud Lake, Little Dollar Lake, Peggley Lake, Hendricks, Hog Island Forest Campground, Rexton Lake. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Loon Lake, Kelsey Pond, Clinton Lake.

*Sphagnum fuscum* is recognized by its brown color and compact growth at the top of hummocks. Unusually dark red-brown expressions of *S. capillaceum* and its var. *tenellum* may confuse the unwary; but even in occasional green shade forms, the stems and wood cylinders of *S. fuscum* are definitely brown, not red. The species is much like *S. capillaceum* var. *tenellum* in the strongly bordered, lingulate, nearly flat stem leaves, with divided, efibrillose hyaline cells. Its chief character is admittedly the brown pigment, and yet the compact hummocks and thread-like branches interwoven inside the hummocks have a characteristic "look" which defies description. A distinctive habitat dignifies its claim to specific rank.

Another brownish species, **S. subfulvum** Sjörs, has been found in nearby Luce and Chippewa Counties. As compared with *S. fuscum,* the tufts are looser and, when dry, shiny. The branch leaves are larger and broader, and the stem leaves more obviously pointed. The border of the stem leaves is only moderately expanded at base, and the hyaline cells are often twice divided. Another means of distinguishing *S. subfulvum* is provided by much larger pores on the outer surface of branch leaves.

←

*Sphagnum russowii.* 95. Stem cortex. 96. Stem leaves. 97. Upper cells of stem leaves. 98. Branch leaves. 99. Cross-section of branch leaf. 100. Cells of branch leaf, inner surface. 101. Cells of branch leaf, outer surface.

*Sphagnum warnstorfii.* 102. Stem leaves. 103. Upper cells of stem leaves. 104. Branch leaves. 105. Cross-section of branch leaf. 106. Cells of branch leaf, inner surface. 107. Cells of branch leaf, outer surface.

*Sphagnum fuscum.* 108. Stem cortex. 109. Stem leaves. 110. Upper cells of stem leaves. 111. Branch cortex. 112. Branch leaves. 113. Cross-section of branch leaf. 114. Cells of branch leaf, inner surface. 115. Cells of branch leaf, outer surface.

21. **Sphagnum capillaceum** (Weiss) Schrank (*S. nemoreum* Scop.)–Plants generally short and compact, green or more often red or red-tinged, not shiny; capitula ± rounded. Wood cylinder reddish; cortical cells of stems in 2-4 layers, thin-walled, without fibrils or pores. Stem leaves oblong-obovate, somewhat pointed and concave at the apex, the border usually poorly differentiated at base; hyaline cells ± fibrillose at least in the apical part of the leaf, with many cells 1-, occasionally 2-divided, rarely with some development of membrane pleats, usually mostly resorbed on the inner surface, often with few to numerous large, rounded membrane gaps on the inner surface. Branches in fascicles of 3-5 (2 normally spreading), with cortical cells in 1 layer, without fibrils, the retort cells with conspicuous necks. Branch leaves imbricate or slightly spreading, small, lanceolate, involute, with a border of linear cells, entire except at the apex; hyaline cells slightly convex on the inner surface, strongly so on the outer, on the inner surface with pores at the ends in the apical part of the leaf, in the lower side regions with other pores nearly as wide as the cells, in all about 2-5, on the outer surface with 5-12 relatively large, elliptic pores along the commissures; in section, green cells triangular to trapezoidal with broader exposure on the inner surface. Usually monoicous. Spores 20-29 $\mu$, very finely papillose-roughened.–n = 19+2, 19+4, 19+4-9.

Darlington, Mosses of Michigan, fig. 22A. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 4 & (ed. 2) Pl. 5 (as *S. capillifolium* var. *viride*). Welch, Mosses of Indiana, fig. 19.–**Fig. 116-122.**

Very common, in open or shady, relatively acid situations. Greenland; Labrador to Alaska and south to North Carolina, the Great Lakes, Arkansas, Colorado, and Washington; Mexico. Europe and Asia.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Douglas Lake, Hogback Bog, Bryants Bog, Gleasons Bog, Gates Bog, Mud Lake, Little Lake 16, Grass Lake, Weber Lake, Pine Grove State Forest Campground. EMMET CO.–Gladys Bog, Bear Creek Township, Stutsmanville, between Levering and Carp Lake, Wilderness State Park. MACKINAC CO.–Rexton Lake, Cranberry Lake, Hog Island Forest Campground, Hendricks, McNamara Pond, Cut River, Epoufette, Bois Blanc Island, Mackinac Island, Prentiss Bay. PRESQUE ISLE CO.–Hammond Bay, Clinton Lake.

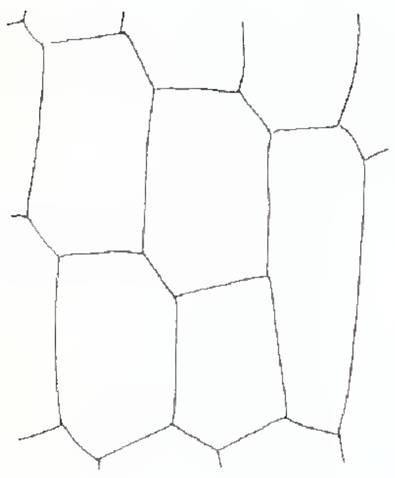
The acute, more or less involute-pointed stem leaves with hyaline cells less commonly divided and somewhat fibrillose aid in distinguishing this from the var. *tenellum*. Stem leaves even more concave and pointed and with abundant pores and fibrils and a weak border indicate the var. *tenerum*. Actually var. *tenellum*, var. *capillaceum*, and var. *tenerum* represent degrees of an isophyllous tendency and are not as distinct as one might wish.

Var. **tenellum** (Schimp.) Andr. (*S. rubellum* Wils.)–Slender, often red plants with ± flattened capitula. Stem leaves oblong or oblong-lingulate (with parallel sides), rounded at the apex, nearly flat, with the border abruptly and conspicuously broadened at base, the hyaline cells mostly 1-2-divided, not or sometimes slightly fibrillose. Branch leaves often curved and subsecund. Generally dioicous.–n = 19+2, 19+4.

Darlington, Mosses of Michigan, fig. 22B.–**Fig. 123-124.**

In open, distinctly acid situations, at the tops of hummocks, more characteristic of raised bogs than soligenous fens. Ranging with the species but relatively uncommon in our essentially minerotrophic peatlands.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge (Carp Creek), Bryants Bog, Livingston Bog, Mud Lake, Gates Bog, Little Lake 16, Grass Lake. EMMET CO.–Stutsmanville, Conway Bog, Big Stone Bay, French Farm Lake. MACKINAC CO.–Rexton Lake, Hendricks, Ozark, Epoufette. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach.



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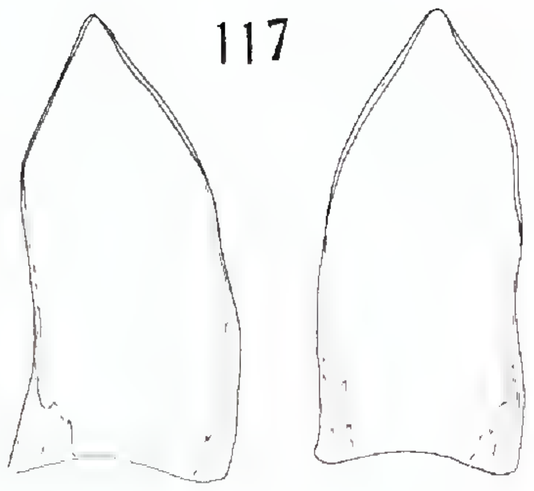

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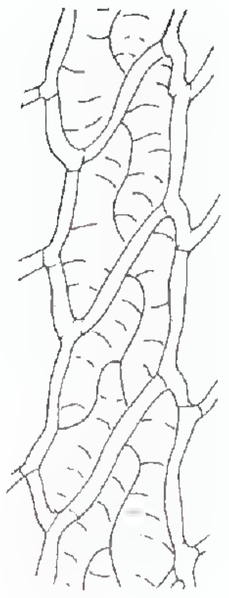

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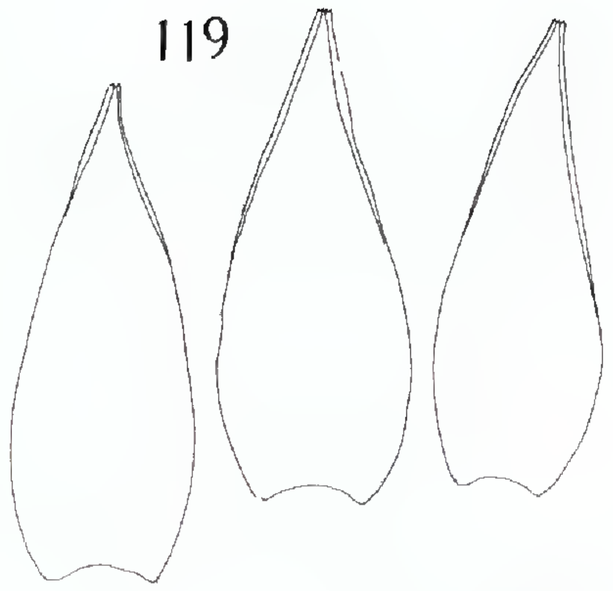

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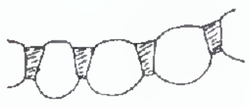

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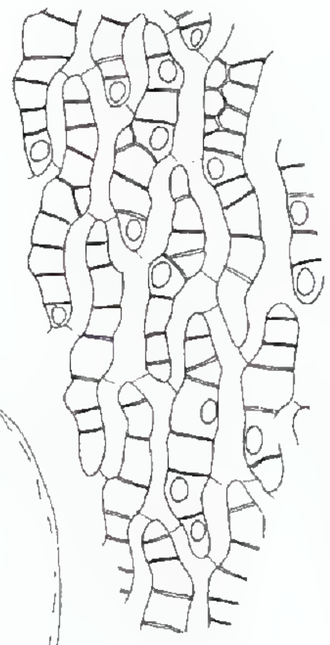

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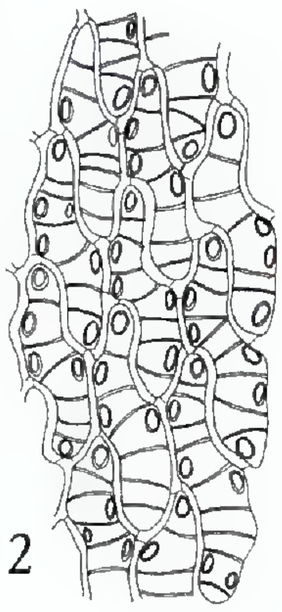

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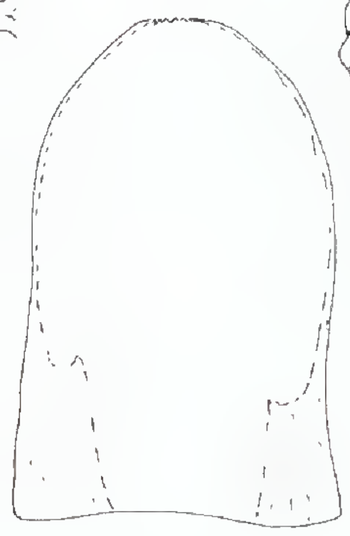

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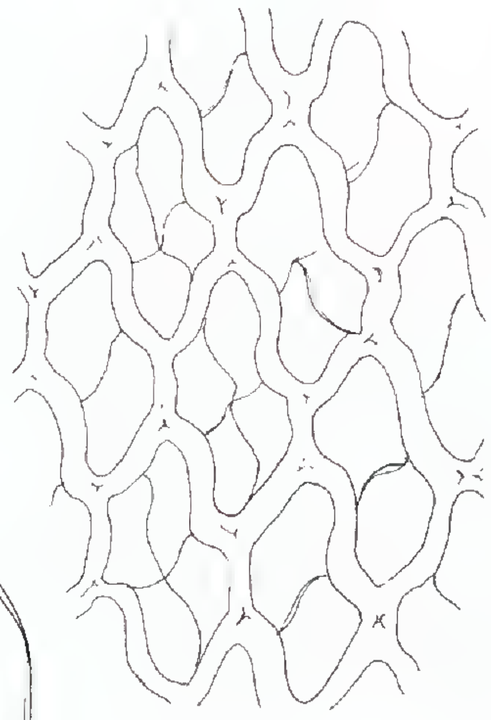

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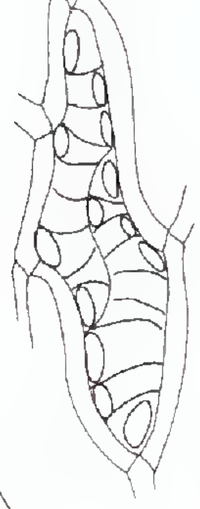

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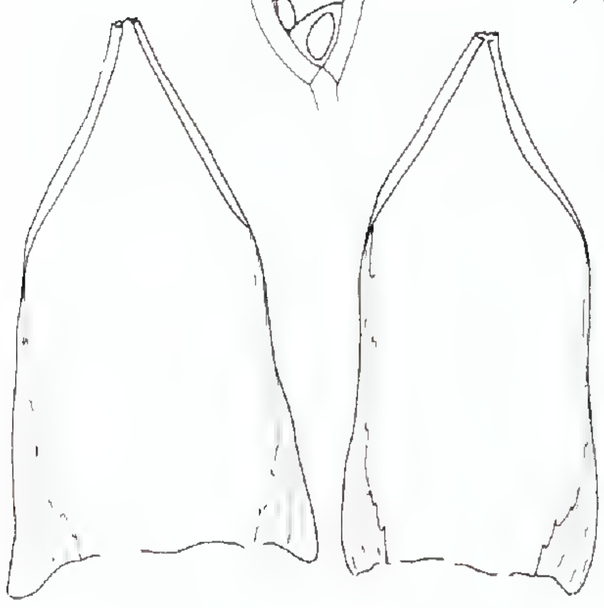


125

*Sphagnum capillaceum.* 116. Stem cortex. 117. Stem leaves. 118. Upper cells of stem leaf. 119. Branch leaves. 120. Cross-section of branch leaf. 121. Cells of branch leaf, inner surface. 122. Cells of branch leaf, outer surface. Var. *tenellum.* 123. Stem leaf. 124. Upper cells of stem leaf. Var. *tenerum.* 125. Stem leaves. 126. Upper cell of stem leaf, outer surface.

The capitula are flattened and not so nicely rounded as in var. *capillaceum* and var. *tenerum.* The flat, lingulate stem leaves rounded at the apex and usually lacking fibrils in the hyaline cells provide the most tangible distinctions from the species proper. The leaves are often somewhat secund when dry. The hyaline cells of the stem leaves are more commonly divided than in *S. russowii.*

Osvald (Acta Phytogeog. Suecica 13: 43. 1940) said that the differences between *S. capillaceum* and the var. *tenellum* seem less distinct in America than in Europe. Andrews once told me the same thing.

Var. **tenerum** (Sull. & Lesq. *ex* Sull.) Crum (*S. tenerum* Sull. & Lesq. *ex* Sull.)–Rather slender, greenish to pinkish plants with small, rounded capitula. Stem leaves relatively large, oblong-ovate, somewhat narrowed and concave at the tip, with the border scarcely to somewhat broadened at base and hyaline cells commonly 1-(rarely 2-)divided, fibrillose nearly throughout the leaf, with numerous large, rounded pores on the inner surface (3-5 per cell) and more numerous elliptic pores along the commissures on the outer surface. Branch leaves imbricate; hyaline cells bulging up to ½ their diameters on the outer surface.–n = 19+6.

Breen, Mosses of Florida, Pl. 133 (fig. 1-7), as *S. tenerum.*–**Fig. 125-126.**–The illustrations in Darlington's *Mosses of Michigan* (fig. 24a) are not very convincing, and the collections apparently referred to in the text are misidentified.

In bog forests and also in more open situations, such as blueberry or tamarack-*Chamaedaphne* bogs. Along the Eastern Seaboard from Newfoundland and Labrador to Florida and the Gulf States, less commonly inland, in Quebec, New York, Ontario, Michigan, North Carolina, Tennessee, Missouri, and, disjunctively, in British Columbia and California; Denmark.

CHEBOYGAN CO.–Livingston Bog, Mud Lake, Gates Bog, Pine Grove State Forest Campground. EMMET CO.–Gladys Bog, Antique Bog, Stutsmanville. MACKINAC CO.–Little Dollar Lake, Ryerse Lake, Hessel, Prentiss Bay.

The plants, variable in overall appearance, most often resemble var. *capillaceum* in miniature, because of dainty, rounded capitula. The var. *tenerum* differs from the var. *capillaceum* in the more isophyllous nature of the stem leaves which approach the branch leaves in shape (being somewhat pointed and concave at the tip and not very strongly bordered at the base) and, more so, in structure (having hyaline cells fibrillose nearly throughout the leaf and porose on both surfaces). The stem leaves of var. *capillaceum* also show a degree of isophylly, but the fibrils are not so well or so extensively developed, and the pores, if present at all, are large, rounded, and restricted to the inner surface.

In extreme form, the var. *tenerum* can scarcely be confused with the var. *capillaceum;* even in less convincing forms, it is a somewhat better segregate than the var. *tenellum.* The habitat preferences need investigation. (The kinds of variations expressed by this complex are discussed under *S. subsecundum,* above).

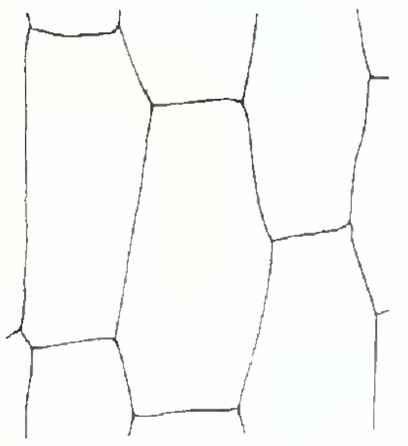
22. **Sphagnum subnitens** Russ. & Warnst. *ex* Warnst.–Rather robust plants in loose, soft mats, yellowish-brown with pale, pinkish, bluish, or purple-brown tinges, somewhat lustrous when dry. Wood cylinder red-brown; cortical cells of stem in 3-4 layers, large and thin-walled, without fibrils or pores. Stem leaves large, oblong or oblong-triangular, broadly acute and abruptly involute-cuspidate, the border not much broadened at the base; hyaline cells without fibrils (or with occasional traces here and there), mostly 1(2)-divided, often with membrane pleats, greatly resorbed on the inner surface. Branches in fascicles of 3-5 (2 spreading), their cortical cells in 1 layer, non-fibrillose, the retort cells with ± inconspicuous necks. Branch leaves lanceolate, involute to a narrow, toothed apex which is ± spreading when dry, bordered by 2-3 rows of linear cells, without a resorption furrow; hyaline cells strongly convex on the outer surface (bulging about 2/3 their diameter), only slightly so on the inner, on the inner surface with pores none or very few, on the outer surface with 2-5 large, elliptic pores at ends and corners; in section, green cells triangular or more often trapezoidal, with broader exposure on the inner surface, the lumen triangular. Monoicous. Spores about 22-28 $\mu$, finely papillose.–n = 19+2, 19+4, 19+5-8.

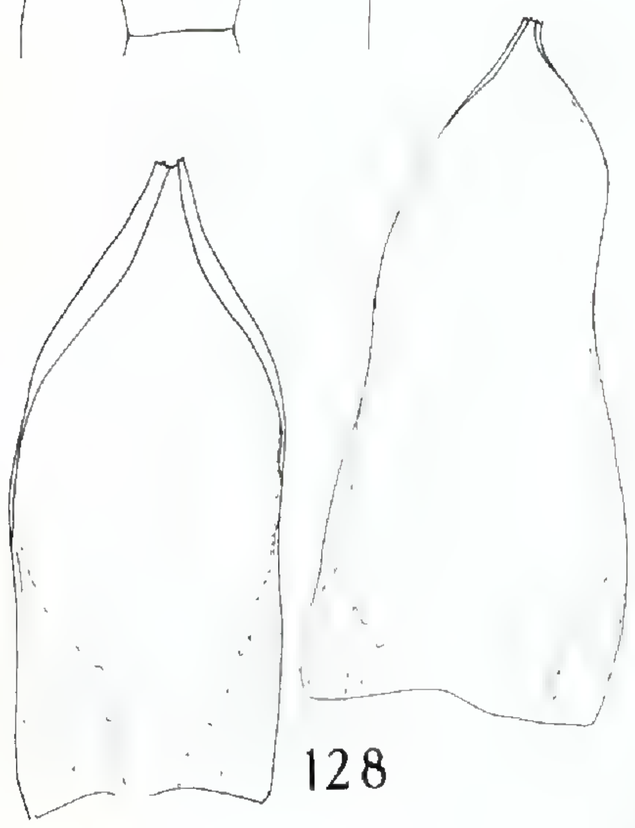
Darlington, Mosses of Michigan, fig. 23 (as *S. plumulosum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 4, (ed. 2) Pl. 5 (as *S. plumulosum*).–**Fig. 127-133.**

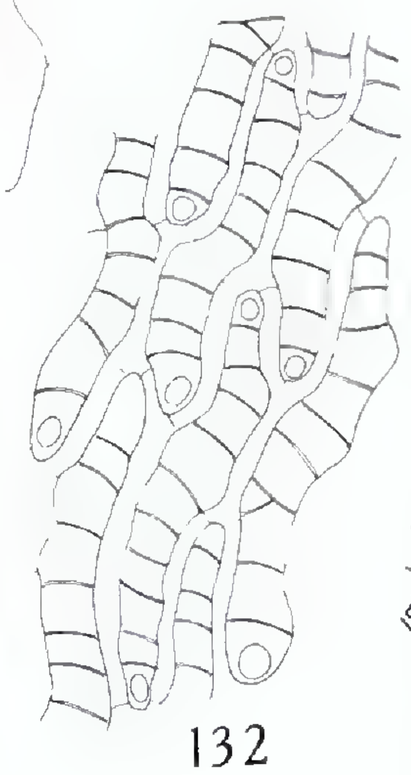
In bog mats and also in bog forests, especially in areas subject to flooding; meso-eutrophic. Circumpolar; Azores; Greenland; British Columbia to California; Labrador to New Jersey and Michigan.

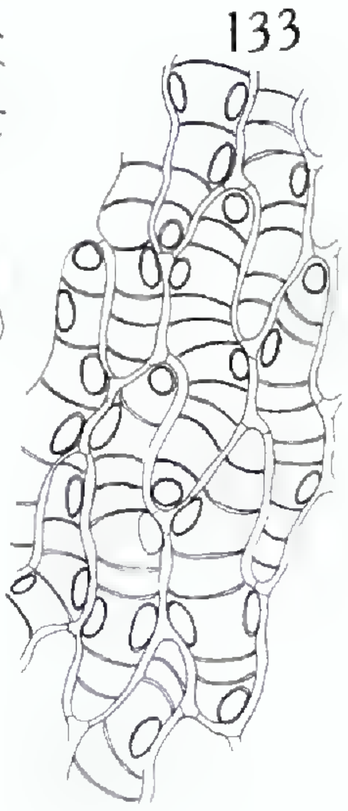
MACKINAC CO.–Epoufette; Peggley Lake.

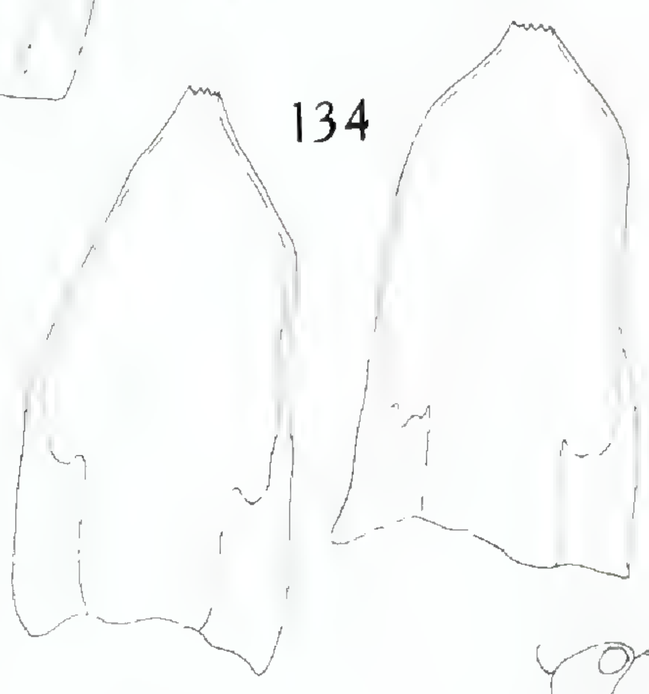
Best recognized by its soft sheen and reddish to bluish tinges. The narrow, spreading leaf tips aid in distinguishing this from **S. subfulvum** Sjörs (fig. 134-139), which has been collected in Luce and Chippewa Counties. *S. subfulvum* is pale-brown (never red). The scleroderm is dark-brown. The stem leaves are 0.8-1.5 mm. long, oblong-lingulate, and rather broadly pointed (not particularly pinched or concave-cuspidate at the tip); and the border is moderately broadened at base; the branch leaves

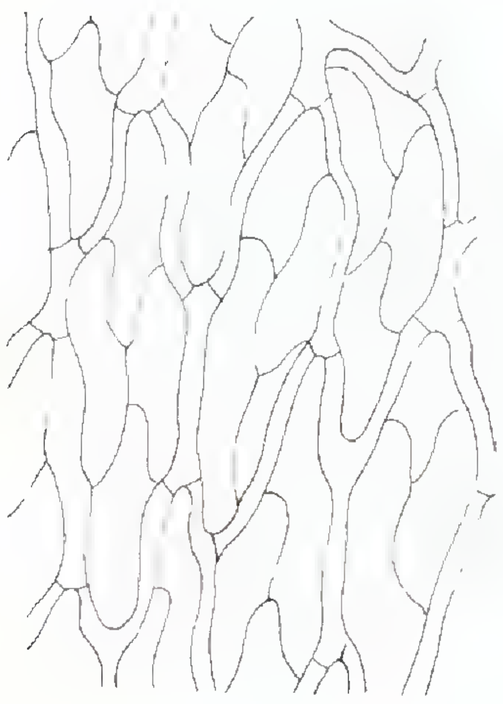


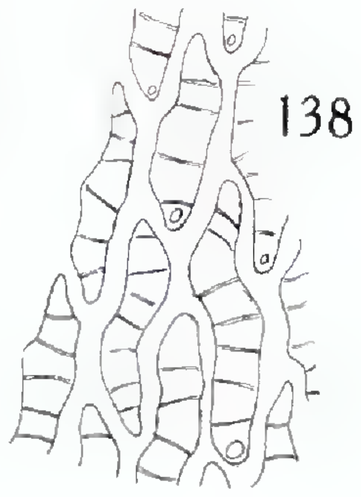



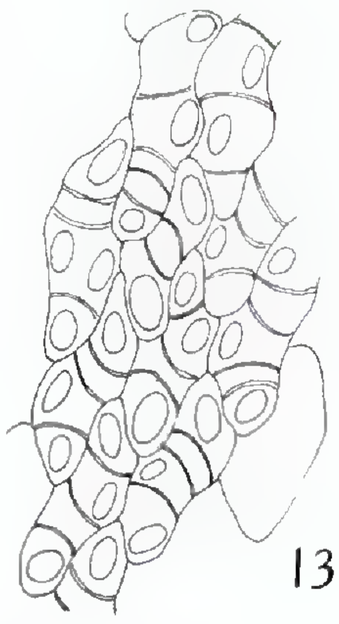


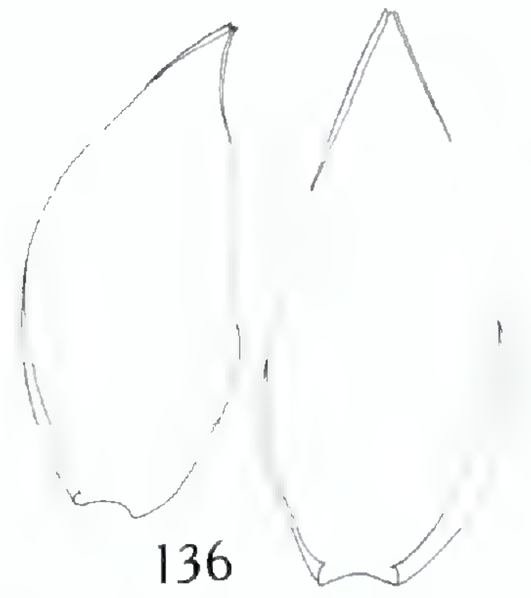



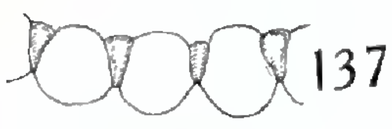




*Sphagnum subnitens.* 127. Stem cortex. 128. Stem leaves. 129. Upper cells of stem leaf. 130. Branch leaves. 131. Cross-section of branch leaf. 132. Cells of branch leaf, inner surface. 133. Cells of branch leaf, outer surface.

*Sphagnum subfulvum.* 134. Stem leaves. 135. Upper cells of stem leaves. 136. Branch leaves. 137. Cross-section of branch leaf. 138. Cells of branch leaf, inner surface. 139. Cells of branch leaf, outer surface.

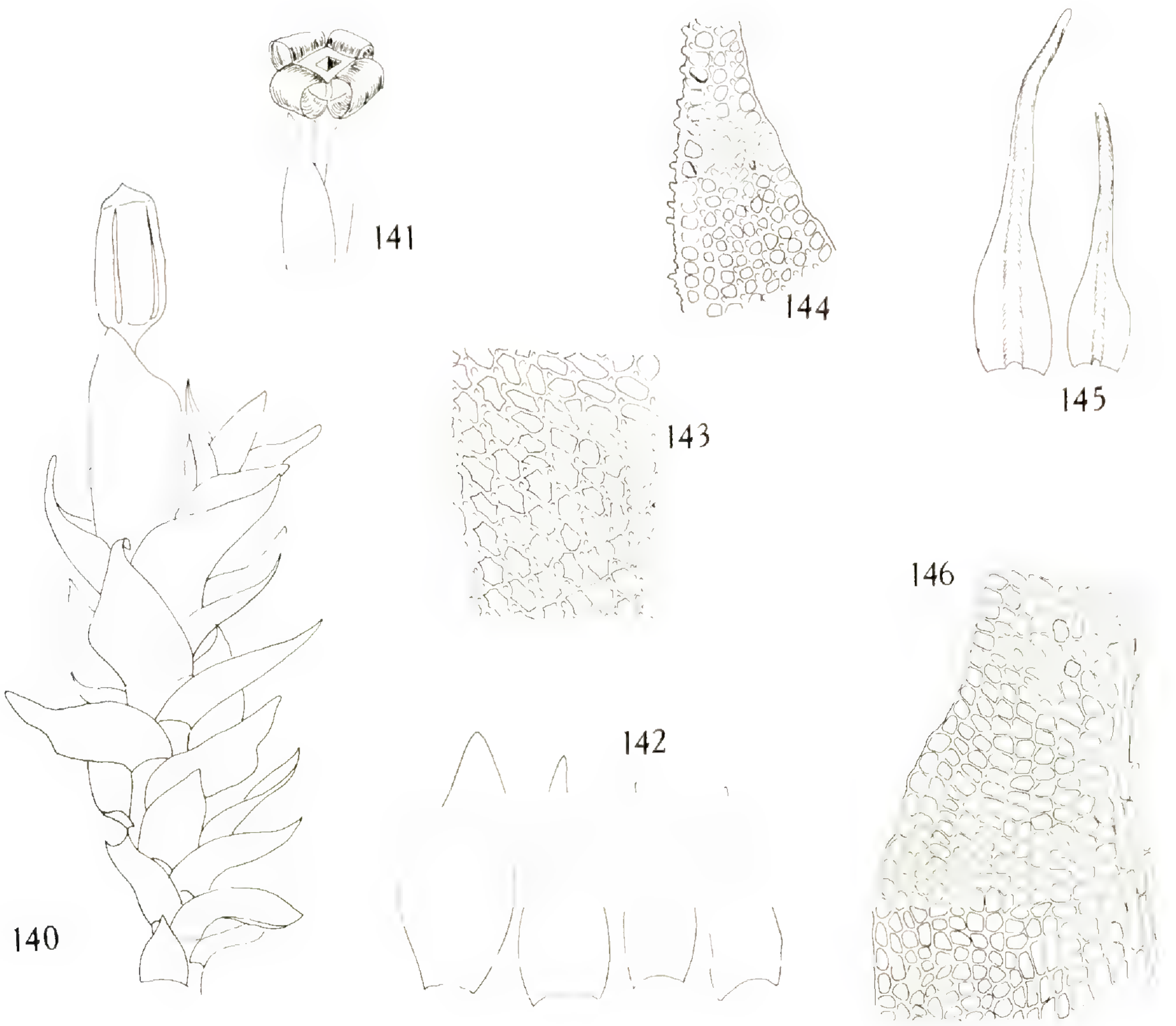
are appressed, ovate-lanceolate, and shortly and broadly pointed. *S. subnitens* is variegated with yellow-brown, pinkish, or violet. Its scleroderm is red-brown. The stem leaves are 1.3-1.7 mm. long, oblong-triangular, broadly acute and abruptly concave-cuspidate, and the border is only slightly broadened at base. The branch leaves are lanceolate, with long, narrow tips which are somewhat spreading when dry.

A certain glossiness is found in all *Sphagna* with hyaline cells convex on the outer, visible surface of branch leaves. The metallic luster of *S. subnitens* and *S. subfulvum* is seen only in the dried condition.

## Class ANDREAEOPSIDA

Protonema normally thallose. Gametophytes small, dark-brown, reddish, or blackish, rigid and brittle, usually growing on rocks. Stems without a central strand, its cells uniformly stereid, containing large oil globules. Leaves various in shape, mostly concave and oblong-ovate or subpanduriform from an erect base; costa single or lacking; cells incrassate and porose, containing oil globules, often papillose. Perichaetial leaves often large and convolute-sheathing. Setae lacking, the sporophyte consisting of foot and capsule, elevated at maturity by a stalk-like pseudopodium (derived from the archegonial stalk); capsule without a peristome, dehiscing by means of 4 (or sometimes 4-8, rarely 10) longitudinal valves; spore sac surrounding the columella, not separated from the capsule wall by air spaces; both sporogenous tissue and columella derived from the endothecium.

A small class of 1 family and 2 genera, neither represented in the local flora, but **Andreaea rupestris** Hedw. (with ecostate, fiddle-shaped leaves–fig. 140-144) and **A. rothii** Web. & Mohr (with costate, narrow, tapered leaves–fig. 145-146) occur on acid rocks in the Upper Peninsula.–The genus *Andreaea* was named for J. G. R. Andreae, an apothecary of Hannover and a friend of Ehrhart's.




*Andreaea rupestris.* 140. Habit. 141. Dry capsule after dehiscence. 142. Leaves. 143. Upper cells of leaf in surface view. 144. Upper cells of leaf in profile.

*Andreaea rothii.* 145. Leaves. 146. Cells at leaf shoulders.

Spores of *Andreaea* commonly begin germination by undergoing their first division before being shed from the capsule. Such precocious germination (similar to that of many leafy liverworts) may have survival value for mosses of rocky exposures where conditions for ecesis are hazardous.

*Andreaea rothii* has a chromosome number of n = 10, 11; *A. rupestris*, n = 10.

## Class BRYOPSIDA

Protonema filamentous. Gametophytes consisting of erect to prostrate leafy stems attached to the substrate by non-living, hair-like rhizoids with ± oblique cross-walls. Branches not grouped at nodes in fascicles. Leaves inserted in 2 or, more often, many ranks, often toothed at the margins but not (or very rarely) lobed, stem and branch leaves often ± dimorphous, rarely dorsal or ventral leaves differentiated from lateral leaves, often costate (with 1 or frequently 2 nerves of varying length). Male and female sex organs borne in bud-like inflorescences on the same or separate plants (sometimes mixed together in the same inflorescence); archegonia narrowly flask-shaped; antheridia vesiculose and cucumber-shaped; paraphyses associated with antheridia, often also with archegonia; perichaetial and perigonial leaves often greatly differentiated. Sporophytes consisting of foot, seta, and capsule, the seta sometimes very short and virtually lacking but usually clearly elongate at maturity, not delicate or short-lived. The capsule dehiscing by means of a lid-like operculum (or rarely indehiscent), the mouth generally fringed by a peristome of 1 or 2 series of teeth in multiples of 4 (usually 16); stomata generally present at or near the base of the capsule; spore sac surrounding a central columella and not overarching it (the columella in *Archidium* lacking); both spore sac and columella derived from the endothecium. Developing sporophyte protected by a calyptra formed by the upper part of the archegonium which continues growth after fertilization and is eventually torn from the vaginula and carried upward as a cap over part or all of the capsule as the seta elongates.

### FISSIDENTACEAE

Plants minute to fairly large, gregarious or tufted, mostly erect, simple or sparsely branched, radiculose only at base. Leaves narrow, lingulate to lanceolate, distichous and complanate, usually crowded or overlapping, seemingly split to the costa on the adaxial side into 2 vaginant laminae which clasp the stem and often the base of the leaf above; costa single and generally well developed (rarely lacking), ending somewhat below the apex to shortly excurrent; cells mostly small, usually unistratose, hexagonal or ± rounded-hexagonal, rarely shortly rhomboidal, smooth to mammillose or papillose, sometimes variously differentiated at the margins. Setae terminal or lateral, elongate, erect or flexuose, often geniculate at base; capsules erect to inclined, symmetric or somewhat curved, often constricted below the mouth, smooth; operculum generally rostrate; peristome teeth 16, red or red-brown, inserted at or near the mouth, forked in the upper 1/3-2/3 (very rarely entire or with rudimentary forks). Spores spherical. Calyptra nearly always cucullate.—A family of about 700 species in one genus (*Fissidens*) and a few species in three segregate genera.

#### **Fissidens** Hedw.

With the characters of the family.—The name means split tooth, referring to the peristome teeth which are generally forked. The equitant leaves (like a rider on

horseback, divided below into vaginant laminae sheathing the stem and usually the next leaf above and thus resembling the leaf of an *Iris*) provide the best means of recognition. By the structure of the costa and other evidence, Salmon (Ann. of Bot. 13: 103-130. 1899) demonstrated that the vaginant laminae constitute the true leaf, and the apical and dorsal laminae can therefore be regarded as outgrowths from it. More recently, however, Robinson (Rev. Bryol. et Lichén. 37: 941-947. 1972) considered the vaginant laminae the true leaf and the apical lamina a part of the true leaf re-oriented vertically rather than an outgrowth from it. The spirally ridged tips of the peristome teeth of most species are also a unique feature of the family.

1. Plants aquatic, coarse, rigid, robust; leaf cells in 2-3 layers — 1. *F. grandifrons*
1. Plants often in moist or even wet places but not submerged, softer, small to medium-sized; cells unistratose (or rarely bistratose in small, scattered patches)
 2. Leaves with a marginal border of linear cells (the border sometimes very short and limited to upper and perichaetial leaves)
  3. Border ending near the apex of all leaves; leaves broadly acute and often apiculate; costa ending no more than 2-3 cells below the apex — 8. *F. bryoides*
  3. Border limited to the vaginant laminae of upper and perichaetial leaves; leaves broadly rounded at the apex; costa ending 2-6 cells below the apex — 7. *F. obtusifolius*
 2. Leaves not bordered by linear cells
  4. Leaves coarsely and irregularly serrate toward the apex, usually bordered by 3-5 rows of pale cells similar in shape to the inner green cells
   5. Leaf cells 6-9, rarely 12 μ, rounded, bulging, bistratose here and there, dark-green and obscure; pale margin usually very distinct — 3. *F. cristatus*
   5. Leaf cells 9-20 μ, hexagonal, flat or somewhat convex, unistratose, not obscure; pale margin slightly to moderately differentiated — 2. *F. adiantoides*
  4. Leaves subentire to crenate or evenly crenate-serrulate, not or only indistinctly paler at the margins
   6. Setae terminal; costa ending 4-11 cells below the apex — 4. *F. osmundoides*
   6. Setae lateral; costa ending in or near the apiculus
    7. Plants autoicous; costa ± brown, ending in a stout, cuspidate apiculus; cells of vaginant lamina inconspicuously unipapillose — 5. *F. taxifolius*
    7. Plants dioicous; costa pellucid, ending at or near a minute, pellucid apiculus; cells of vaginant lamina smooth or inconspicuously 2-3-papillose — 6. *F. bushii*

1. **Fissidens grandifrons** Brid.—Plants aquatic, robust, rigid, dark- or blackish-green, often lime-encrusted, freely and irregularly branched, 1.5-10 cm. high. Leaves 3-4.5 mm. long, crowded and overlapping, rigidly erect-spreading, scarcely altered on drying, oblong-linear or oblong-lanceolate, bluntly acute or gradually tapered to a narrow, rounded tip, crenulate all around, unbordered; dorsal lamina scarcely tapered, usually not reaching the stem; costa ending near the apex, covered by short cells; cells opaque, pluristratose (2-3-stratose near the costa above, thinner toward the margins), irregularly rounded-hexagonal, ± incrassate, bulging. Inflorescences and sporophytes not seen.—n = 16.

Conard, How to Know the Mosses, (ed. 2) fig. 35a-b. Grout, Mosses with Hand-lens and Microscope, fig. 28.—**Fig. 147-150.**

Attached to limestone rocks or pebbles and submerged in running water or springs. Circumpolar; widespread in North America, south to Guatemala.

CHEBOYGAN CO.–Mill Creek, Sturgeon River, Pigeon River. EMMET CO.–Ramona Beach. MACKINAC CO.–Mackinac Island.

Distinctive in habitat, aspect, and structure. The leaves are composed of several layers of cells making them opaque and rigid. The plants rarely fruit but apparently reproduce by means of axillary buds which become radiculose and are readily detached in flowing water (see Hill, Bryol. 5: 56-58. 1902).

**Fissidens fontanus** (B.-Pyl.) Steud. (fig. 151-153) has long, narrow, flaccid leaves of one layer of cells. According to Mrs. Britton (Bryol 5: 83. 1902), the fruits fall off

147

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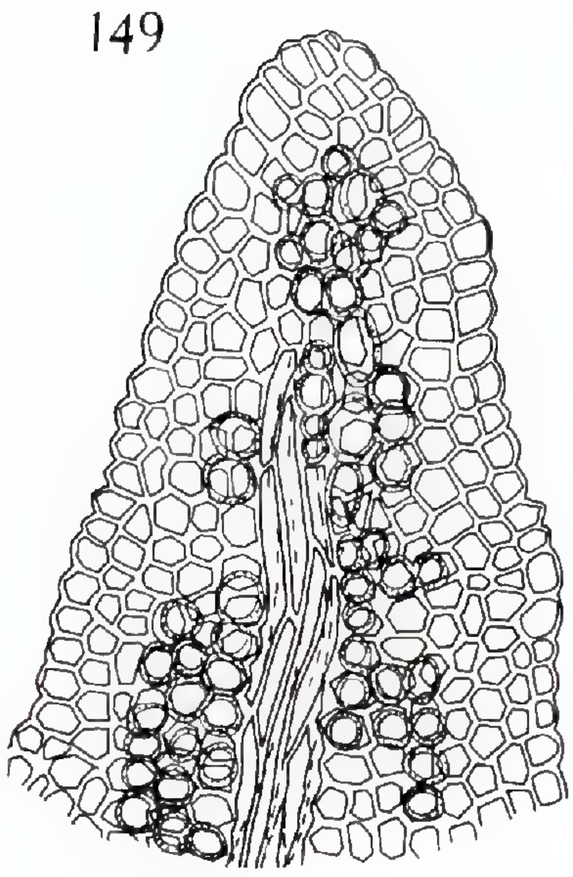

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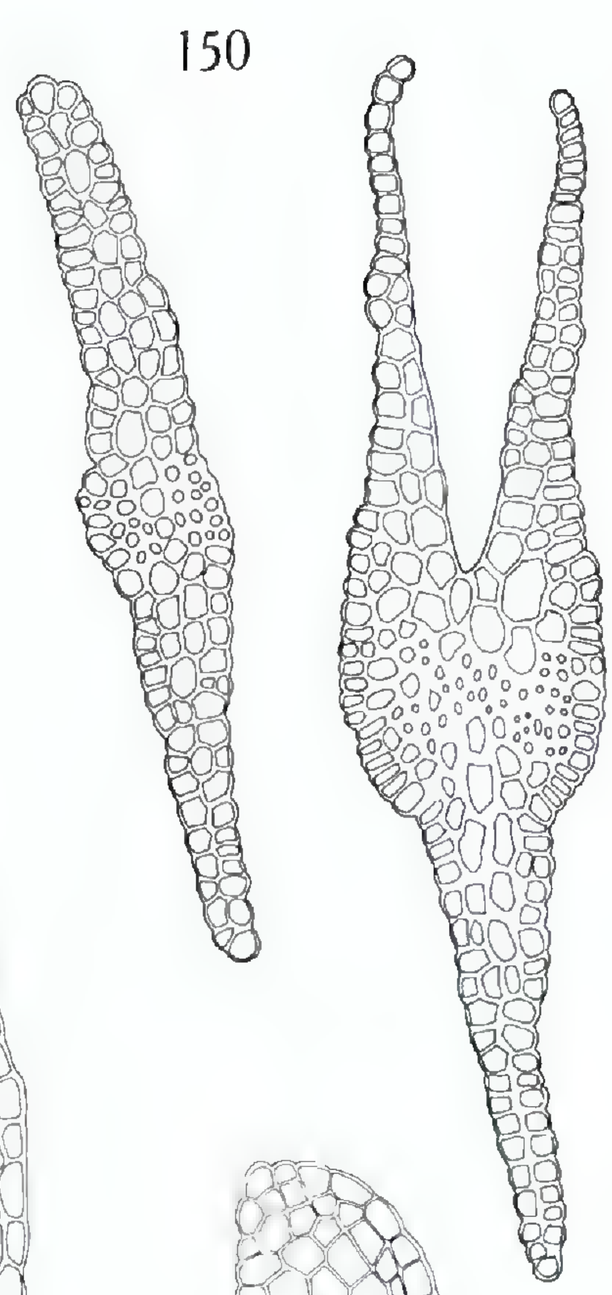

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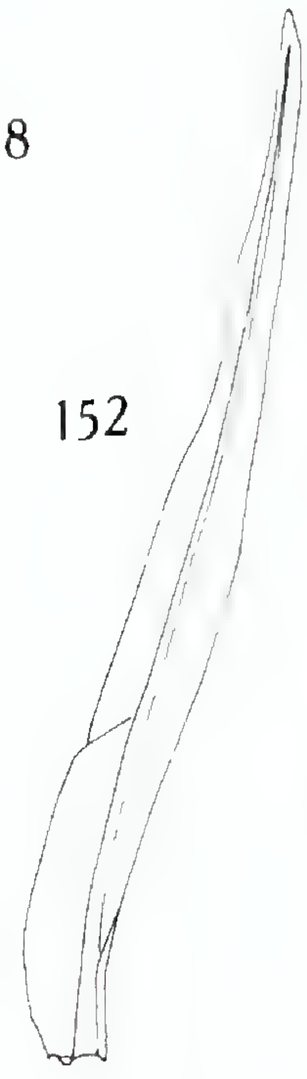

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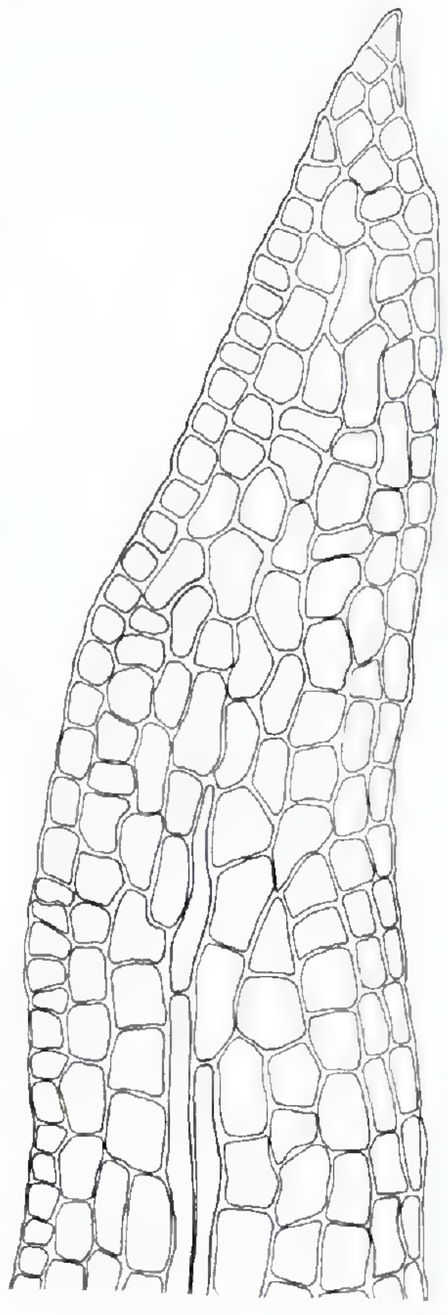

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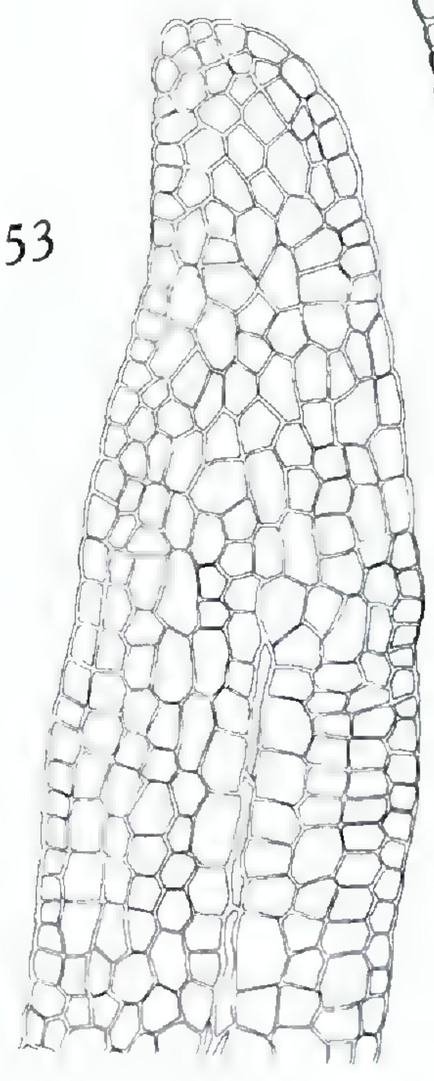


*Fissidens grandifrons.* 147. Habit. 148. Leaf. 149. Cells at leaf apex. 150. Cross sections of leaf.

*Fissidens fontanus.* 151. Habit. 152. Leaf. 153. Cells at tips of two leaves (at different magnifications).

just before maturity and float on the surface, many of them quite green, with the calyptra still attached. She illustrated such a calyptra from which a new plant had sprouted. *F. fontanus* occurs in its usual habitat in southern Michigan, submerged in brooks or in places periodically inundated, such as hardwood swamps, and has been reported from deep waters of Lake Michigan and Lake Erie (at 18 to 34 feet) and from bottom samples of undetermined depth in Lake Superior and Lake Ontario (Hiltunen, Mich. Bot. 5: 62-63. 1966). I have, subsequent to that report, seen a specimen taken at 35 feet in Lake Superior.

William Ellison recently found a few mosses on the bottoms of lakes in the Douglas Lake region, none at great depths: *Calliergon giganteum* at 1 m., *Scorpidium*

*scorpioides* at 1-2 m., and *Drepanocladus aduncus* at 3 m. in Arnott Lake, Emmet Co.; *Drepanocladus exannulatus* at 1 m. in a ditch near Sherett Lake, Emmet Co.; *Drepanocladus aduncus* up to 2 m. in Lancaster Lake, Cheboygan Co.; and *Fissidens grandifrons* at 6-10 m. in Lake Huron. He found no bryophytes in Douglas, Burt, Mullett, Munro, and Vincent Lakes, all in Cheboygan Co.

Lake Tahoe, on the border between California and Nevada, is one of the deepest lakes in the world, with a maximum depth of 1645 ft. and an average depth of 1027 ft. It is also remarkable for extreme light penetration and low primary productivity. It is, in fact, ultra-oligotrophic. Yet Frantz & Cordone (Ecol. 48: 709-714. 1967) found algae, mosses, and liverworts as low as 500 ft. Their bryophyte records are given here, with depths in feet:

MUSCI

*Fissidens adiantoides,* 244
*F. grandifrons,* 244, 329, 400
*Brachythecium* sp., 342
*Eurhynchium* sp., 329, 392, 400
*Hygrohypnum* sp., 400
*H. molle,* 225, 283, 285, 299
*H. luridum,* 290
*Leptodictyum riparium,* 100-408
*L. riparium fo. fluitans,* 251
*Porothamnium bigelovii,* 329, 392
*Fontinalis nitida,* 400

HEPATICAE

*Blepharostoma arachnoideum,* 329, 362
*Chiloscyphus fragilis,* 199, 342, 362, 400

*Thamnobryum alopecurum* was found on a bit of limestone at a depth of 200 ft. in Lake Geneva (Schnetzler, Bot. Centralbl. 23: 330-331. 1885). In Crater Lake, Oregon, Hasler (Jour. Wildl. Manag. 2: 94-103. 1938) recorded *Fontinalis* and *Drepanocladus* at "astonishing depths of 394 feet." Depth records from other lakes are less notable. For example, Williams (Bryol. 33: 32. 1930) and Juday (Ecol. 15: 325. 1934) reported three bryophytes–*Drepanocladus fluitans* var. *submersus, Fontinalis antipyretica,* and *Chiloscyphus rivularis,* at depths of 44-66 feet in Wisconsin lakes.

Persson (Bot. Notis. 1942: 308-324. 1942) reported 21 bryophytes from the bottoms of several lakes in northern Sweden. In one lake as many as 15 species were found in luxuriant masses and especially around beds of water lilies (both *Nymphaea* and *Nuphar*). An association with water lilies suggests to me a preference for calcareous and eutrophic conditions, as does Persson's belief that bryophytes are favored in lakes richly sedimented owing to fluvial or glacial influences. His records, with depths in meters, follow:

MUSCI

*Fissidens adiantoides,* 2-5.5
*Bryum pseudotriquetrum,* 1-6
*Cinclidium stygium,* 3-5
*Meesia triquetra,* 1-3
*Fontinalis antipyretica,* 1-5.5
*F. hypnoides,* 0.5-6
*Eurhynchium riparioides,* 1-5.5
*Campylium helodes,* 3-5
*C. polygamum,* 0.5-4
*Calliergon megalophyllum,* 0.5-5
*C. trifarium,* 1-3
*Calliergonella cuspidata,* 2-5
*Scorpidium scorpioides,* 0.5-5.5
*Drepanocladus aduncus,* 2.5-5
*D. exannulatus,* 0.5-5
*D. sendtneri,* 0.5-5.5
*D. trichophyllus,* 0.5-3

HEPATICAE

*Riccardia sinuata,* 3-4
*Chiloscyphus pallescens,* 2-5
*C. polyanthus,* 3-4

A specimen of *Scorpidium scorpioides* (*in herb.* MICH) from the Tuktoyatuk Peninsula in Canada's Northwest Territories, was collected by J. H. Dickson, submerged at 50 ft. in a *Carex cordorrhiza* mire.

It is curious that many of the bryophytes found on lake bottoms are not normally aquatic or amphibious.

2. **Fissidens adiantoides** Hedw.—Plants about 10-35 (rarely 90) mm. high. Leaves 1.5-4.5 mm. long, broadly oblong, acute or occasionally obtuse, ± wavy, crenulate below, unevenly serrate at apex, usually ± bordered by 4-5 rows of paler cells; dorsal lamina ± rounded and undulate at base; costa pellucid, ending 2-3 cells below the apex, often somewhat sinuose above; cells 10-16 $\mu$, hexagonal, often rounded at the corners, somewhat convex or nearly plane, usually not particularly obscure, unistratose. Dioicous. Setae lateral, 7-15 (rarely 23) mm. long, straight or flexuose, reddish; capsules 1-1.5(2.5) mm. long, suberect to inclined, often curved, often constricted below the mouth when dry; annulus of 1-2 rows of small, persistent cells; operculum 0.7-1 mm. long, long-rostrate, sometimes oblique; peristome teeth finely papillose in vertical rows below, ± papillose at the tips. Spores 16-26 $\mu$, green, very finely papillose. Calyptra cucullate.—n = 12, 19, 20, 21, 24.

Breen, Mosses of Florida, Pl. 1 (fig. 7).—**Fig. 154-155.**

On soil or humus, rocks, logs, stumps, or bark of exposed roots or tree bases, in woods. Europe; Greenland; Alaska to Oregon and Wyoming and Labrador to Minnesota and south to the Gulf of Mexico.

CHEBOYGAN CO.—Douglas Lake, Reeses Bog, Carp Creek, Gorge of Carp Creek, Iron Bridge, Fontinalis Run, near Levering, Mill Creek, Duncan Bay, Grass Bay, Stewart Creek (Black Lake). EMMET CO.—Arnott Lake, Maple River, Pleasantview Swamp, Cecil Bay, Big Stone Bay, Conway Bog, Bear Creek Township, Wycamp Creek. MACKINAC CO.—Bois Blanc Island, Hendricks. PRESQUE ISLE CO.—Mast Point, Hammond Bay, Evergreen Beach, Grand Lake, Ocqueoc Falls, Clinton Lake.

The cells of the leaf margins are only moderately differentiated from the inner cells which are similarly plane or nearly so. In *F. cristatus* the inner cells are smaller, bulging on both surfaces, and bistratose here and there, resulting in an opaque tissue contrasting with the border of flat, translucent cells. Identification is easy in most instances, although there is a degree of intergradation with *F. cristatus*, especially in cell size. But the resemblance to *F. cristatus* should not be over-emphasized. Anderson and Bryan (Rev. Bryol. et Lichénol. 25: 254-267. 1956) produced cytological evidence of a rather remote relationship (in spite of the fact that the chromosome numbers, in some populations, suggest a polyploid series).

3. **Fissidens cristatus** Wils. *ex* Mitt.—Plants 10-25 mm. high. Leaves 1.5-3.5 mm. long, broadly oblong, acute to obtuse, sometimes broadly apiculate, evenly crenulate below, unevenly serrate at apex, clearly bordered by 3-5 rows of pale cells, often somewhat wavy; dorsal lamina abruptly rounded and undulate at base; costa pellucid, ending 2-6 cells below the apex, often ± sinuose above; cells small, 6-9 or sometimes 12 $\mu$, obscure, rounded, bulging, irregularly bistratose. Dioicous. Setae lateral, 5-10 mm. long, reddish; capsules 1.2-1.9 mm. long, suberect to inclined; annulus of 1-2 rows of small, persistent cells; operculum 1-1.5 mm. long, erect or oblique, long-rostrate; peristome teeth finely papillose in vertical lines below, papillose above (the tips with prominent projections at the articulations). Spores 14-20 $\mu$, green, finely papillose. Calyptra cucullate.—n = 12, 12+1, 13+2, 16.

Breen, Mosses of Florida, Pl. 1 (figs. 5-6). Conard, How to Know the Mosses, (ed. 2) fig. 38a-d. Darlington, Mosses of Michigan, fig. 27. Grout, Moss Flora of North America 1: Pl. 6 left. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 11, (ed. 2) Pl. 15. Welch, Mosses of Indiana, fig. 43.—**Fig. 156-158.**

On soil or humus, bark of exposed roots or bases of tree, rotten wood, and rocks, in woods. Europe, Asia Minor, and eastern Asia; Philippine Islands; eastern North America from Nova Scotia to Minnesota and south to the Gulf of Mexico; Arizona; Aleutian Islands.

CHEBOYGAN CO.–Gorge of Carp Creek, Reeses Bog, Wolfs Bog, Mud Lake. EMMET CO.–Arnott Lake, Galloway Bog, Pellston, Maple River, Pleasantview Swamp. MACKINAC CO.–Mackinac Island, Gros Cap, Ozark, Caffey Corner. PRESQUE ISLE Co.–Rainy River Falls, Clinton Lake.

The specific epithet refers to the differentiated leaf margin resembling a crest (such as a rooster's comb) made conspicuous by irregular serrations and pale cells contrasting with the small, dark, bulging cells within.

4. **Fissidens osmundoides** Hedw.–Plants 5-12 (rarely 40) mm. high. Leaves 1-2.2 mm. long, oblong, broadly acute to obtuse or rounded, sometimes ± apiculate, evenly crenulate, ± serrulate at apex, often slightly pale at the margins; dorsal lamina rounded or abruptly narrowed at base; costa pellucid, ending 4-11 cells below the apex, ± sinuose above; cells 10-14(18) $\mu$, irregularly hexagonal, ± thin-walled, not or slightly bulging. Dioicous. Setae terminal, 3-7 mm. long, straight or flexuose, red; capsules 1-1.5 mm. long, suberect or inclined; annulus of 1 row of small, persistent cells; operculum 1.1 mm. long, erect, long-rostrate; peristome teeth finely papillose in vertical rows below, with straight, vertical ridges at the tips. Spores 13-18 $\mu$, green, smooth. Calyptrae mitrate-rostrate.–n = 11, 12, 16.

Grout, Mosses with Hand-lens and Microscope, fig. 25. Welch, Mosses of Indiana, fig. 40.–**Fig. 159.**

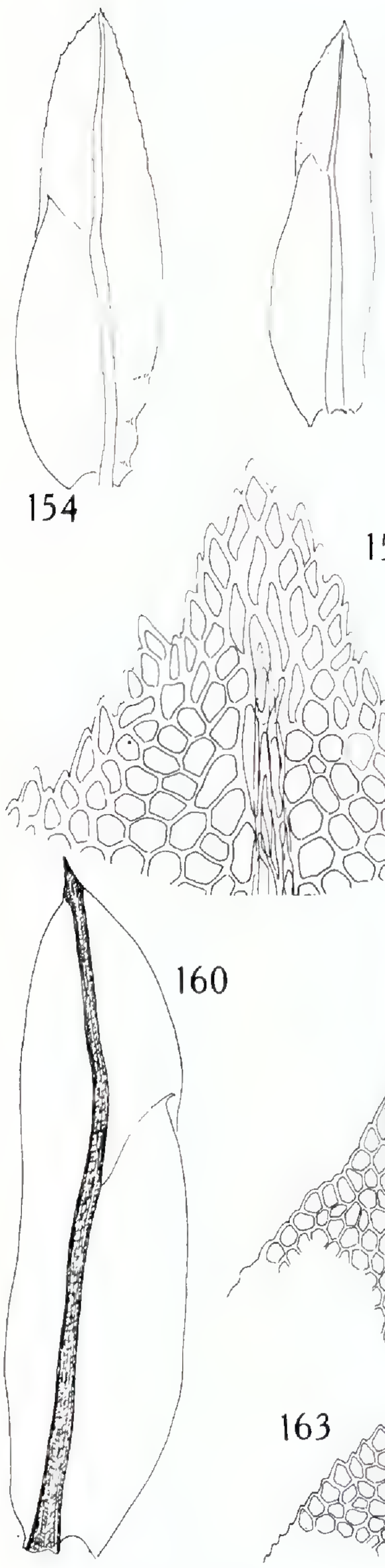
On soil, humus, rocks, or logs, in woods. Europe; Greenland to Alaska, south to Colorado in the West and to Georgia and Arkansas in the East.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge, Mud Lake, Duncan Bay, Grass Bay. EMMET CO.–Levering, Arnott Lake, Pleasantview Swamp, Cecil Bay, Big Stone Creek, Conway Bog. MACKINAC CO.–Bois Blanc Island, St. Martins Point, McKays Creek, Peggley Lake, McNamara Pond. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Clinton Lake.

The evenly crenulate leaf margins as well as the costa ending well below the leaf apex adequately characterize this species. (The leaf margins are often rather pale but by no means as well differentiated as in *F. cristatus* or *F. adiantoides.*) The leaves of many species of *Fissidens* give a neatly pinnate effect suggesting a fern frond and accounting for such names as *osmundoides, adiantoides, asplenioides,* and *polypodioides.*

5. **Fissidens taxifolius** Hedw.–Plants small, 4-8 mm. high. Leaves 1.5-2.2 mm. long, oblong, obtuse or broadly acute, abruptly cuspidate, ± wavy, evenly crenate-serrulate, rarely faintly pale-margined; dorsal lamina rounded and ± undulate at base; costa pellucid, disappearing in the cuspidate tip; cells 7-9(11.5) $\mu$, rounded-hexagonal, thin-walled, bulging; cells of vaginant laminae bluntly and inconspicuously unipapillose. Autoicous; perigonium on a short, basal branch. Setae lateral, 8-11 mm. long, reddish, straight or flexuose; capsules 1.2-1.5 mm. long, inclined, slightly curved, constricted below the mouth; annulus of 1-2 rows of small, persistent cells; operculum 1 mm. long, obliquely long-rostrate; peristome teeth finely papillose (sometimes vertically papillose-striolate below, papillose at the tips). Spores 13-19 $\mu$, green, very finely papillose. Calyptra cucullate.–n = 9, 10, 12, 12+1, 24.

Breen, Mosses of Florida, Pl. 8 (figs. 6-7). Conard, How to Know the Mosses, (ed. 2) fig. 39a-b. Grout, Mosses with Hand-lens and Microscope, fig. 26, Moss Flora of North America, 1: Pl. 8 upper left. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 11, (ed. 2) Pl. 15. Welch, Mosses of Indiana, fig. 38.–**Fig. 160-161.**




*Fissidens adiantoides.* 154. Leaf. 155. Cells at leaf tip.
*Fissidens cristatus.* 156. Habit. 157. Leaf. 158. Cells at leaf tip.
*Fissidens osmundoides.* 159. Cells at leaf tip.
*Fissidens taxifolius.* 160. Leaf. 161. Cells at leaf tip.
*Fissidens bushii.* 162. Leaf. 163. Cells at leaf tip.
*Fissidens subbasilaris.* 164. Leaves. 165. Cells at leaf tip.

A calciphile, growing on soil and rock. Europe, eastern Asia, and the Caribbean; British Columbia and Washington and widespread in eastern North America from Nova Scotia to South Dakota, south to Florida and Texas.

EMMET CO.–Cecil Bay.

The leaves are about 1.5-2.2 mm. long, with a dark, often brownish costa disappearing in a stout, cuspidate apiculus, and the cells of the vaginant laminae are

inconspicuously unipapillose. These features contrast with those of *F. bushii,* in which the leaves are only about 1-1.5 mm. long, with a pellucid costa ending short of the small apiculus but similar to it in color and thus appearing to be excurrent, and the cells of the vaginant laminae are smooth or rarely and indistinctly 2-3-papillose.

6. **Fissidens bushii** (Card. & Thér.) Card. & Thér.—Small plants 4-7 mm. high. Leaves 1-1.5 mm. long, oblong, broadly acute to rounded-obtuse, abruptly narrowed to a small, pellucid apiculus, crenate-serrulate all around, serrulate at the tip, often faintly pale-margined; dorsal lamina abruptly narrowed or rounded at the base; costa pellucid, ending near the apiculus but similar to it in color and thus appearing excurrent; cells 7-9 $\mu$, green and somewhat obscure, irregularly bistratose, rounded-hexagonal, thin- or firm-walled, distinctly bulging, those of the vaginant laminae not or rarely very indistinctly roughened by 2-3 low, blunt papillae. Dioicous; both male and female buds basal. Setae 6-10 mm. long, red-yellow, erect or flexuous; capsules 1 mm. long, suberect to inclined, ± curved, somewhat constricted below the mouth when dry; annulus of 1-2 rows of small,persistent cells; operculum 1 mm. long, obliquely rostrate; peristome teeth finely papillose in vertical rows below, indistinctly spiral-thickened above. Spores 14-18 $\mu$, finely papillose. Calyptrae cucullate.

Conard, How to Know the Mosses, (ed. 2), fig. 39c. Grout, Moss Flora of North America, vol. 1, Pl. 12c.—**Fig. 162-163.**

On soil and occasionally on rocks, in open woods or in exposed, disturbed places; a calciphile. Widespread in eastern North America from Maine and Ontario south to Florida and Texas.

CHEBOYGAN CO.—E. of Mullet Lake.

The costa ends somewhat short of the small apiculus but appears to be joined to it because of a similar whitish-pellucid color. In *Fissidens taxifolius,* by contrast, a dark-green or brownish costa nearly fills the stout, cuspidate apiculus and appears to be excurrent.

Though not likely to be confused with this, or any of the local species, **Fissidens subbasilaris** Hedw. (fig. 164-165), found only once in southern Michigan but widely distributed elsewhere in eastern North America, deserves mention. The plants are small and dark-green, and the upper portion of the costa is covered by short, green cells and therefore appears dark and dull, even as viewed with a lens.

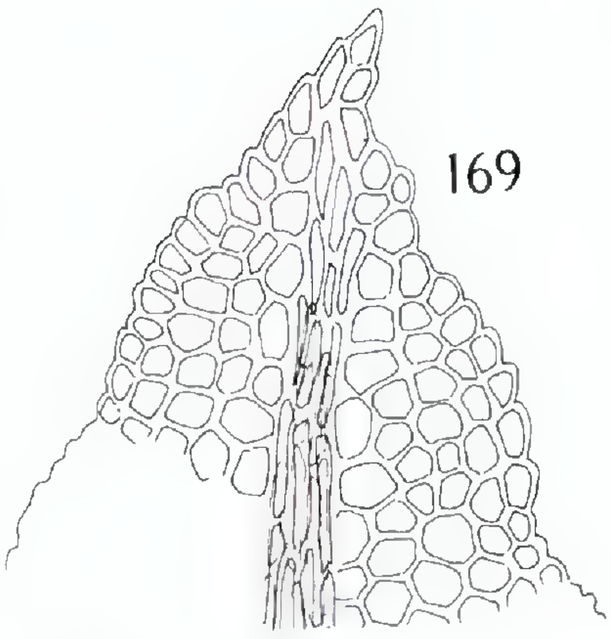
7. **Fissidens obtusifolius** Wils.—Small plants. Leaves 1.5-3.5 mm. long, oblong-lingulate, broadly rounded at the apex, subentire, the perichaetial leaves bordered by linear cells, sometimes very shortly and indistinctly but sometimes nearly the length of the vaginant laminae; dorsal lamina broad, tapered or ending rather abruptly near the leaf base; costa ending well below the apex; cells smooth, very irregularly hexagonal, thin-walled to ± incrassate. Dioicous. Setae terminal, 3 mm. long, rather stout, ± flexuose; capsules 0.5-0.7 mm. long, erect; annulus of 1-2 rows of small, persistent cells; operculum conic, 3 mm. long; peristome teeth finely papillose below, spirally ridged above. Spores 16-18 $\mu$, greenish, very finely papillose. n = 6.

Breen, Mosses of Florida, Pl. 5 (fig. 1-3). Conard, How to Know the Mosses, (ed. 2) fig. 36a-b. Grout, Mosses with Hand-lens and Microscope, fig. 24, Moss Flora of North America 1: Pl. 8, left middle. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 10, (ed 2) Pl. 14. Welch, Mosses of Indiana, fig. 35.—**Fig. 166-167.**

On wet limestone (and perhaps on other kinds of rock as well) in or along streams. Arizona, Michigan, Minnesota, and Indiana. Endemic to North America.

MACKINAC CO.—Bois Blanc Island.

166



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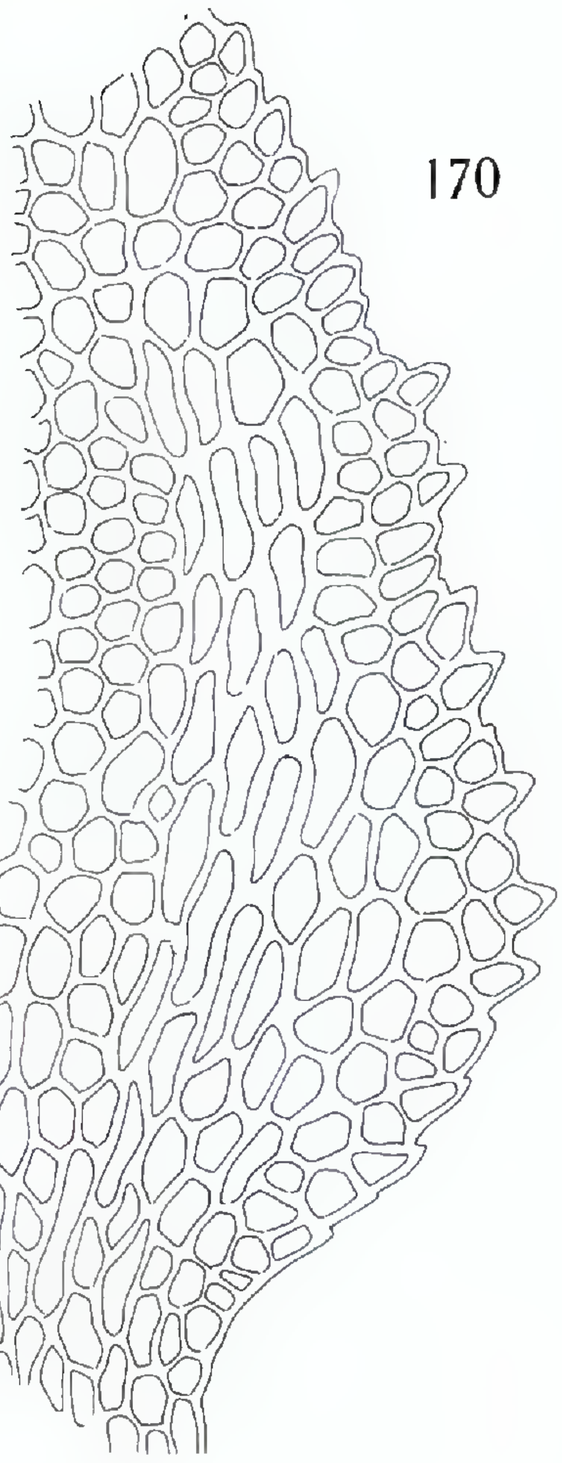

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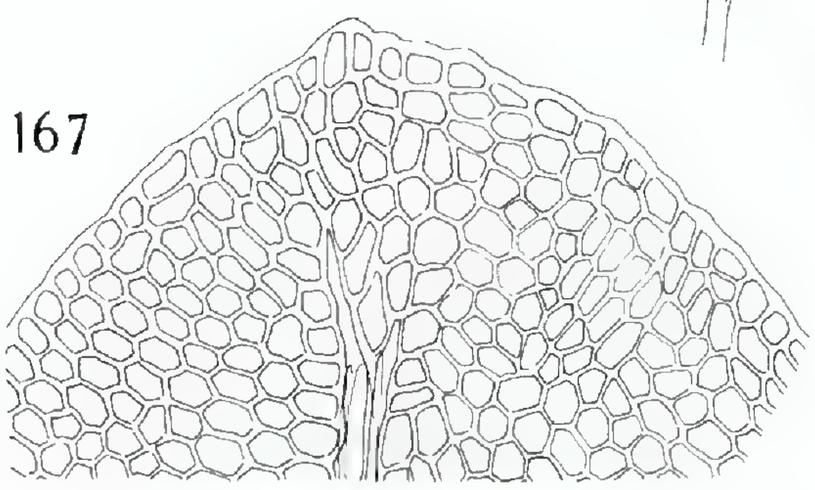


167

*Fissidens obtusifolius.* 166. Habit. 167. Upper cells of leaf.
*Fissidens exilis.* 168. Habit. 169. Cells at leaf tip. 170. Cells at base of vaginant lamina.

The small, very flat, shiny plants with rounded leaf tips can be taken for some kind of leafy liverwort. The species has not yet been found in our area, although it occurs along the Tahquamenon River in Luce County. Material previously reported from Mackinac Island as the var. *apiculatus* Grout is acutely *F. exiguus* (a form of *F. bryoides* with leaves bordered only toward the base). The var. *apiculatus* differs from the typical variety in having leaves with a longer costa, broadly acute and sometimes more or less apiculate apex, and smaller, more irregular cells. It has been found in southern Michigan.

*Fissidens obtusifolius* is often associated with *Didymodon rigidulus* and *Hyophila involuta.* The latter (see fig. 300-304) has not been found in our area although it may be expected in our few wet limestone habitats..

**Fissidens exilis** Hedw. (fig. 168-170), an extremely rare species, has been found on moist soil near Grand Ledge in Eaton County. It is recognized by its small size and bluntly serrate vaginant laminae which have a suggestion of an intramarginal border formed of elongate inner cells. I have seen other collections from northern and central Europe and American localities in Maryland, New York, Ohio, and Pennsylvania, where it grows as scattered plants from an abundant protonema on wet, bare clay in disturbed places, such as roadbanks.

8. **Fissidens bryoides** Hedw.—Small plants 2-7 mm. high. Leaves 1-2 mm. long, oblong to oblong-lingulate, obtuse to gradually or rather abruptly acute, sometimes cuspidate; margins typically bordered by hyaline, linear cells extending to the apex or

nearly so but occasionally limited to the vaginant laminae or extending varying distances upward; dorsal lamina tapered, often ending above the leaf insertion; costa ending slightly below the apex, percurrent, or frequently extending into the apiculus and sometimes appearing confluent with the border; cells (6)9-13(16) $\mu$, hexagonal, thin-walled, smooth and ± pellucid or somewhat bulging and rather obscure, not conspicuously enlarged at the base. Inflorescences variable, sometimes in the same collections, dioicous, synoicous, or autoicous (with ♂ buds basal or axillary). Setae terminal, 3-7 mm. long, straight or ± flexuose, often abruptly bent at the base, yellow or yellow-brown; capsules erect or ± curved and inclined, constricted below the mouth when dry; annulus of 1-2 rows of small, persistent cells; operculum conic or conic-rostrate; peristome teeth bifid, minutely papillose below, spirally ridged above. Spores 11-21 $\mu$, green, very finely papillose. Calyptra cucullate.–n = 5 (also as *F. minutulus* and *F. viridulus*), 10 (also as *F. minutulus*), 11 (as *F. exiguus* and *F. minutulus*), 12.

Breen, Mosses of Florida, Pl. 3 (as *F. bryoides, F. viridulus* & var. *texanus, F. pusillus,* & *F. minutulus*), 6 (as *F. andersonii* & *F. exiguus* var. *falcatulus*). Grout, Mosses with Hand-lens and Microscope, figs. 21, 22 (as *F. incurvus*), 23 (as *F. minutulus*), Moss Flora of North America 1: Pl. 5 (as *F. exiguus, F. minutulus,* & *F. viridulus*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 10 (as *F. bryoides* & *F. incurvus* var. *minutulus*), 11 (as *F. exiguus*), (ed. 2) Pl. 14 (as *F. bryoides* & *F. minutulus*), 15 (as *F. exiguus*). Welch, Mosses of Indiana, fig. 32 (as *F. minutulus*), 33, 34 (as *F. exiguus*).–**Fig. 171-177.**

On moist soil and rock, often in or along brooks, rarely on exposed roots. Circumpolar, very widely distributed in North America.

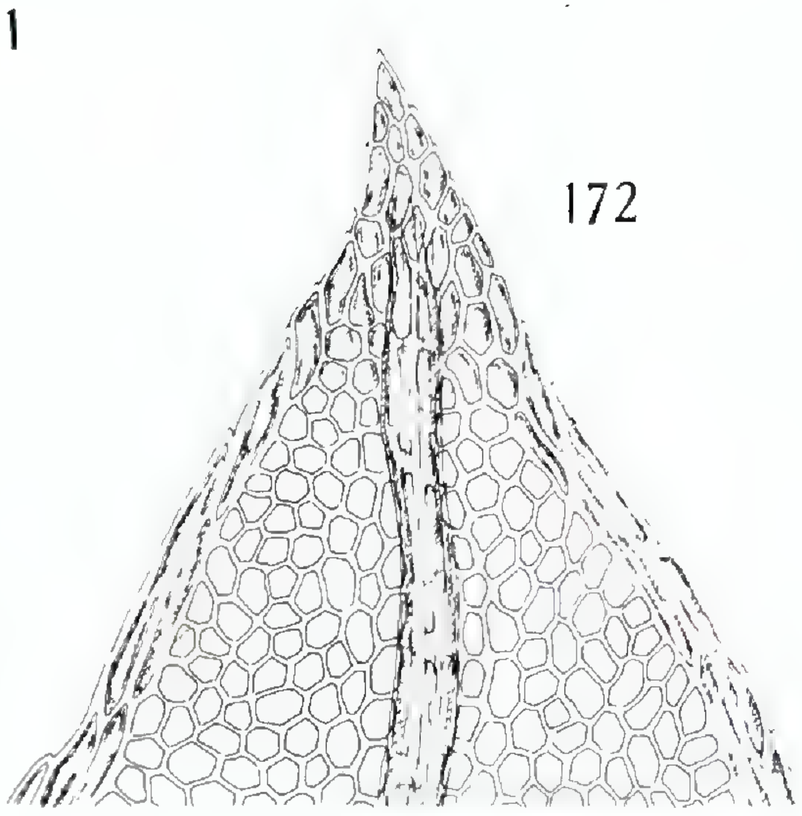
Typical *F. bryoides* does not occur in our area. In the local flora are three recognizable forms which could be referred to *F. viridulus* (Sw.) Wahl., *F. minutulus* Sull., and *F. exiguus* Sull. CHEBOYGAN CO.–Mill Creek ("*F. exiguus*"). EMMET CO.–Brutus ("*F. viridulus*"), Galloway Bog, Big Stone Creek ("*F. viridulus*"). MACKINAC CO.–Mackinac Island, Bois Blanc Island, McKays Creek, Gros Cap, Caffey Corner ("*F. viridulus*"; some material from Mackinac Island is "*F. minutulus,*" verging on "*F. viridulus*").

I take an extremely conservative view of *F. bryoides.* It is possible to demonstrate, sometimes in the same collections, apparently dioicous plants, as well as autoicous and synoicous ones. At its best development, *F. bryoides* has small, rather convex, and relatively obscure leaf cells, whereas *F. viridulus* usually has larger, flatter, more pellucid cells, but there is no constancy in cell characteristics in any of the forms included here. The relative length of the leaf border and development of the apiculus are equally worthless because of gradation from **F. bryoides** (with a strong border often confluent with a strong apiculus–fig. 171-172), to **F. viridulus** (with the border ending a few cells below the apex–fig. 173), to **F. minutulus** (with the border slightly shorter and with an acute or sometimes bluntly apiculate apex–fig. 174), and through **F. pusillus** (fig. 175) to **F. exiguus** (with a short border ending near the apex of the vaginant lamina but frequently extending well above it in some leaves–fig. 176-177). Apparently differences do exist, in habitat and times of fruiting, but the variants cannot be distinguished by purely taxonomic means and should be investigated ecologically, cytologically, and otherwise for biological rather than morphological differences.

Smith, studying a part of the problem, in Great Britain (Trans. Brit. Bryol. Soc. 6(1): 56-68. 1970), considered *F. minutulus* a synonym of *F. viridulus.* I certainly agree, although the problem is geographically and taxonomically greater than that. His paper serves as a model of techniques useful in analyzing species of variable and overlapping characteristics.

According to W. J. Hooker (in Smith's *English Flora,* 1844), "The moss which engaged Mungo Park's attention so much in Africa as to revive his drooping spirits

171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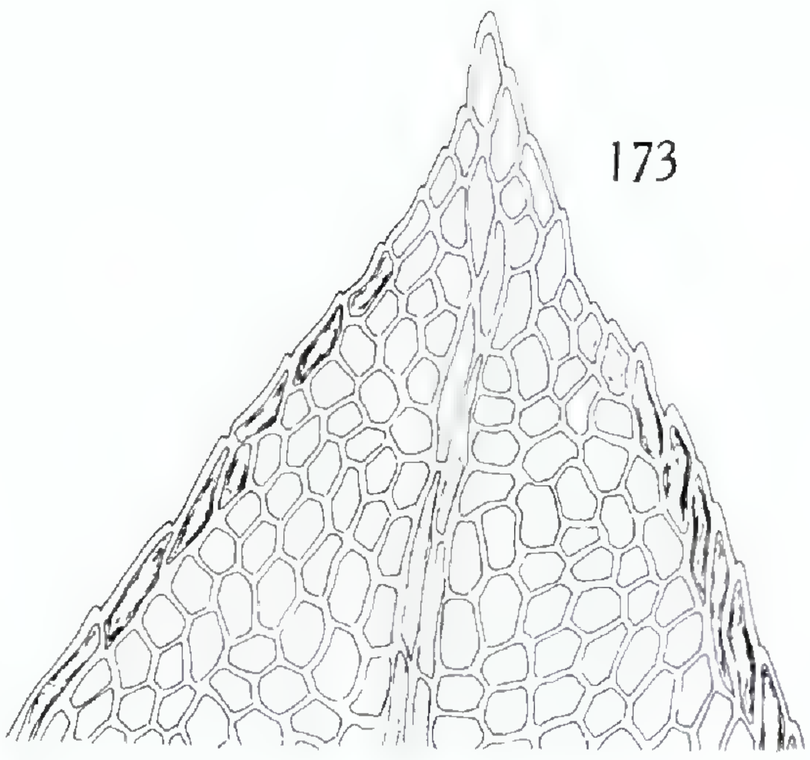
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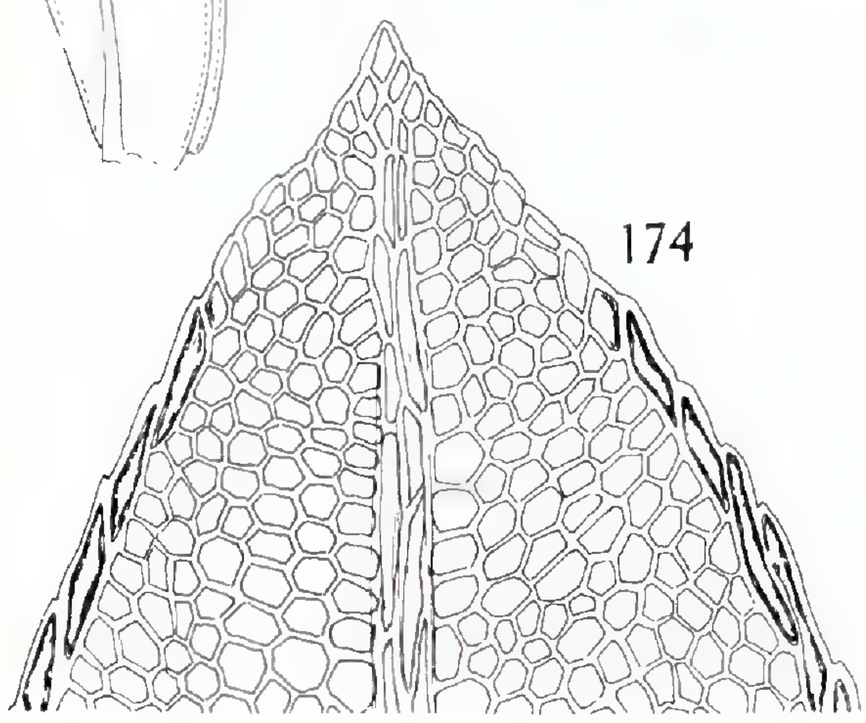
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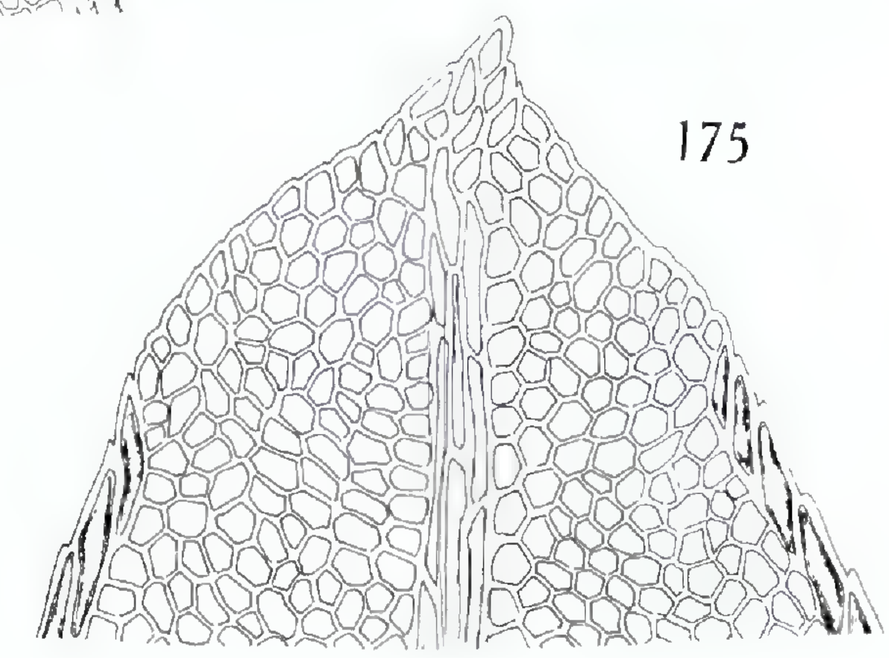
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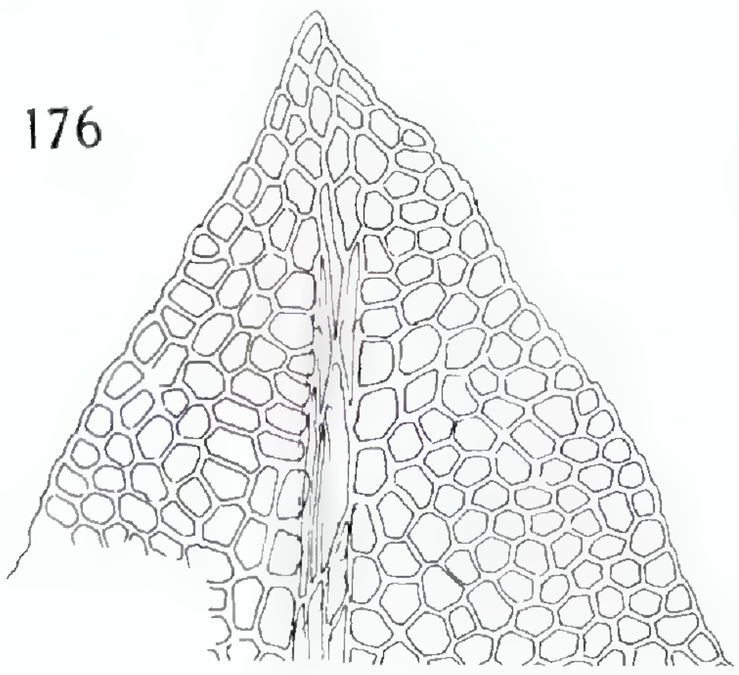
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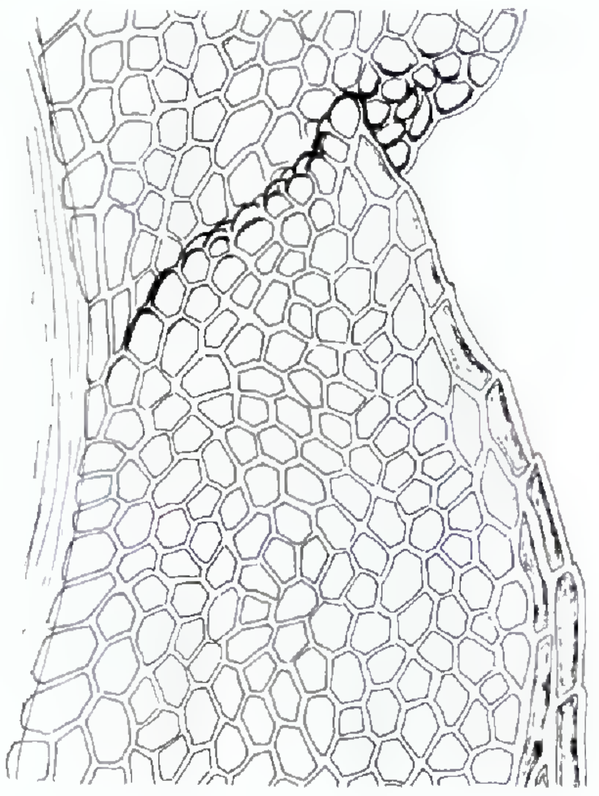

177

*Fissidens bryoides, sensu lato*, showing variation in the development of the leaf border in various so-called species. 171. Leaf (*F. bryoides, sensu stricto*). 172. Cells at leaf apex (*F. bryoides, sensu stricto*). 173. Cells at leaf apex ("*F. viridulus*"). 174. Cells at leaf apex ("*F. minutulus*"). 175. Cells at leaf apex ("*F. pusillus*"). 176. Cells at leaf apex ("*F. exiguus*"). 177. Cells at margin of vaginant lamina ("*F. exiguus*").

when sinking under fatigue is this species, as I have ascertained by means of original specimens given to me by his brother-in-law, Mr. Dickson."

Mungo Park was an African explorer who was captured by Arabs but managed to escape after four months and made his way back to England, arriving there in 1797 after 19 months of hardship. Sick, clothed in rags, and destitute, he faced a journey of 2000 miles through unknown country, alone. In addition to other vicissitudes—such as hunger—he was robbed of his precious compass, and, in fact, all but shirt, trousers, and hat. He wrote, in his *Travels in the Interior of Africa,* "I considered my fate as certain,

and that I had no alternative but to lie down and perish. . . . At this moment, painful as my reflections were, the extraordinary beauty of a small moss in fructification irresistibly caught my eye. I mention this to shew from what trifling circumstances the mind will sometimes derive consolation; for though the whole plant was not larger than the top of one of my fingers, I could not contemplate the delicate conformation of its roots, leaves, and capsula without admiration. Can that Being (thought I), who planted, watered, and brought to perfection in this obscure part of the world a thing which appears of so small importance, look with unconcern upon the situation and sufferings of creatures formed after his own image? Surely not! Reflections like these would not allow me despair. I started up, and disregarding both hunger and fatigue, travelled forwards, assured that relief was at hand."

Stark, in his *Popular History of British Mosses,* moralized:

> Sad, faint, and weary, on the sand
> Our traveller sat him down; his hand
> Cover'd his burning head.
> Above, beneath, behind, around,
> No resting for the eye he found;
> All nature see'd as dead.
>
> One tiny tuft of Moss alone
> Mantling with freshest green a stone
> Fix'd his delighted gaze;
> Through bursting tears of joy he smiled,
> And while he raised the tendril wild,
> His lips o'erflow'd with praise.
>
> O! shall not He who keeps thee green,
> Here in the waste, unknown, unseen,
> Thy fellow-exile save?
> He who commands the dew to feed
> Thy gentle flower, can surely lead
> Me from a scorching grave.

When Park returned to Africa in 1805, his luck ran out. He perished in rapids on the Niger during an attack by natives.

Somewhat like the Fissidentaceae because of crowded and distichous leaves, are the Bryoxiphiaceae, consisting of a single rare species, **Bryoxiphium norvegicum** (Brid.) Mitt., the SWORD MOSS (fig. 178-180). It has not been found in Michigan although it occurs in many scattered localities in the eastern United States. Because it is most often found on ancient sandstone outcrops–in Hocking County, Ohio, and at Turkey Run in Indiana, for example–Steere (Ecol. 18: 346-358. 1937) suggested that it may be a preglacial and interglacial relic in scattered areas that escaped glaciation. He thus related its distribution to that of Cordilleran disjuncts far eastward in the Keweenaw Peninsula of Michigan and the Shickshock Mountains of the Gaspé, which Fernald publicized as possible nunataks. (The idea has failed to gain acceptance, although the extensive literature on the nunatak hypothesis is still interesting and worthwhile.)

## SELIGERIACEAE

Plants minute and gregarious or larger and tufted, simple or forked, not tomentose. Leaves ± subulate from a narrow base; costa flat below, terete above and often filling most of the subula, subpercurrent to excurrent; cells smooth, small and generally short above, oblong-rhomboidal below, usually not differentiated at the basal angles. Setae usually elongate, erect or somewhat curved; capsules mostly exserted,

erect and symmetric, cylindric or shortly pyriform, sometimes wide-mouthed when dry and empty; operculum rostrate; peristome teeth usually present, 16, lanceolate, entire or sometimes slightly perforate or split at the tips. Calyptrae mostly cucullate.

## **Seligeria** BSG

Very small or minute, gregarious plants, erect, simple or forked. Leaves small below, longer and more crowded above, lanceolate to linear, usually long-subulate from a lanceolate base; costa subpercurrent to excurrent, often filling most of the subula; cells smooth, short above, rhomboidal to rectangular or linear below, not differentiated at the basal angles. Autoicous. Setae ± elongate, straight or ± curved, sometimes cygneous, yellow or yellow-brown; capsules exserted, erect, subcylindric, subglobose, or shortly obovoid, usually with a short neck, smooth; annulus none; operculum obliquely rostrate; peristome teeth usually present, generally inserted below the mouth, acute or truncate to emarginate, smooth. Spores spherical, brownish. Calyptrae cucullate, smooth, naked, brown.–Named for Ignaz Seliger, a Silesian pastor, this genus is remarkable for the exceedingly small size of both gametophytes and sporophytes.

Peristome lacking; setae erect or ± flexuose; capsules wide-mouthed when dry and empty
1. *S. donniana*

Peristome present; setae usually ± curved or sinuose; capsules subcylindric when dry and empty
2. *S. campylopoda*

1. **Seligeria donniana** (Sm.) C. M.–Plants up to 1.5 mm. long. Leaves erect, not much altered on drying, 0.2-1 mm. long (including the perichaetial leaves), linear from a narrowly lanceolate base, acute, irregular at the margins; costa filling most of the fleshy subula; cells green and subquadrate to short-rectangular above, pale and oblong-linear below. Perichaetial leaves 0.7-1 mm. long, ovate-lanceolate, serrulate at the shoulders. Setae 1.5-3 mm. long, yellow, erect or ± flexuose; capsules 0.35-0.55 mm. long, shortly obovoid, hemispheric or wide-mouthed when dry and empty; operculum 0.15-0.35 mm. long; peristome none. Spores 8-11 $\mu$, smooth.–n = 12+1, 13.

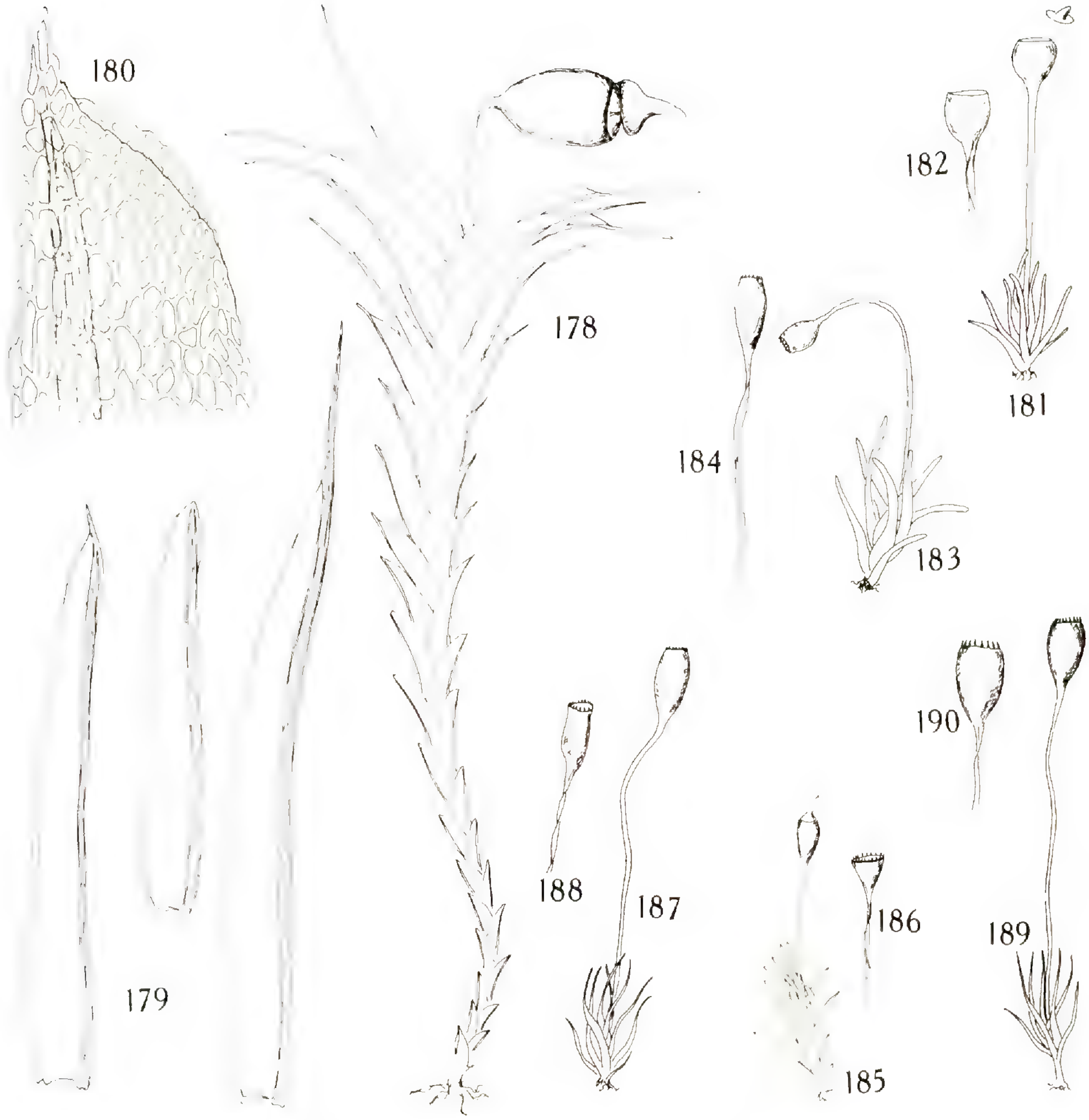
Grout, Moss Flora of North America, 1: Pl. 35 upper left.–**Fig. 181-182.**

On calcareous rock, in moist, shaded places, generally on cliffs. Europe and northern Asia; Alberta, Michigan, and Ontario.

MACKINAC CO.–Mackinac Island.

In spite of its extremely small size, this rare species is easily recognized by its wide-mouthed capsules lacking a peristome.

2. **Seligeria campylopoda** Kindb. *ex* Macoun & Kindb.–Plants 1-2 mm. high. Leaves erect or erect-spreading and ± curved when dry, spreading when moist, 0.7-1 mm. long (including perichaetial leaves), linear or linear-lanceolate (not setaceous), gradually and broadly acuminate, blunt or sometimes acute; margins entire or ± irregular above, often ± recurved below; costa not filling the subula, percurrent or ending well below the apex; cells small and incrassate, rounded-quadrate or shortly oblong above, usually short below, rectangular or oblong-lienar near the insertion. Perichaetial leaves ovate-lanceolate, gradually or rather abruptly acuminate. Setae yellow, 1.5-3 mm. long, usually ± curved (sometimes arcuate or somewhat sinuose), sometimes nearly erect; urn 0.45-0.6 mm. long, subcylindric, brownish (yellow when




*Bryoxiphium norvegicum.* 178. Habit. 179. Leaves. 180. Cells at leaf tip.
*Seligeria donniana.* 181. Habit (moist). 182. Dry capsule.
*Seligeria campylopoda.* 183. Habit (mosit). 184. Dry capsule.
*Seligeria calcarea.* 185. Habit (moist). 186. Dry capsule.
*Seligeria recurvata.* 187. Habit (moist). 188. Dry capsule.
*Seligeria pusilla.* 189. Habit (mosit). 190. Dry capsule.

moist); peristome inserted below the mouth, lanceolate, acute or truncate, brownish or red-brown, 130-170 $\mu$ high. Spores 9-10 $\mu$, smooth or nearly so.

Conard, How to Know the Mosses, (ed. 2) fig. 107a-c. Grout, Moss Flora of North America, 1: Pl. 35A.–Fig. 183-184.

On limestone, particularly on cliffs but also frequently on pebbles, in dry or moist, shaded places. Northern Europe; British Columbia, Washington, Alberta, and Montana and in the East from New Brunswick through the Great Lakes, south to Iowa and Pennsylvania.

CHEBOYGAN CO.–Grapevine Point, Colonial Point, Mill Creek. EMMET CO.–Near Mackinaw City, Big Stone Bay. MACKINAC CO.–Bois Blanc Island, Mackinac Island, Gros Cap.

Only a bryologist is likely to see the tiny Seligerias, and yet they can be easily found by the informed collector in moist, calcareous habitats, such as shaded cliffs, especially in the Great Lakes-St. Lawrence area and the northern Rocky Mountains. *S.*

*compylopoda* is rather common in our area. A huge glacial erratic boulder along the road at Big Stone Bay used to present a vulgar display of thousands of plants of *S. campylopoda,* but a sign attracting tourists to a rock millions of years old soon brought doom to the colony!

**Seligeria calcarea** (Hedw.) BSG (fig. 185-186) has been collected in nearby Alpena County. It differs from *S. campylopoda* most notably in having capsules widest at the mouth (especially when dry), setae straight or nearly so when moist, and leaf cells firm- but not thick-walled.

Elsewhere, in the Upper Peninsula, are *S. recurvata* (Hedw.) BSG and *S. pusilla* (Hedw.) BSG.–**S. recurvata** (fig. 187-188) has setae curved to cygneous when moist and capsules subcylindric and not widest at the mouth even when dry; it differs from *S. campylopoda* in having setaceous, acute leaves with the costa essentially filling the subula and excurrent. **S. pusilla** (fig. 189-190) has setae erect or nearly so when moist and capsules widest at the mouth, especially when dry and empty; it resembles *S. calcarea* but has leaves gradually narrowed to a setaceous, acute subula which is not or only slightly fleshy at the tip.

Another member of the family found in wet crevices of siliceous rocks in the Upper Peninsula is **Blindia acuta** (Hedw.) BSG. The plants are larger (1-7 cm. high) and dioicous, with swollen and conspicuous male buds, and the leaves have colored and inflated alar cells.

## DITRICHACEAE

Plants minute or rather small, gregarious or tufted. Stems erect, simple or forked. Leaves mostly lanceolate, acuminate or subulate, rarely sheathing at base, rarely distichous; costa single, subpercurrent to long-excurrent; cells smooth or rarely roughened because of thickened cross-walls, firm-walled or incrassate, subquadrate or short-rectangular to linear, not differentiated at the basal angles or forming a marginal border. Setae usually elongate; capsules sometimes immersed to emergent and subglobose but usually long-exserted and ± cylindric, erect to strongly inclined, often ± curved or asymmetric; operculum and annulus usually differentiated; peristome teeth present (except in cleistocarpous genera), 16, usually variously split or perforate nearly to the base (or rarely irregularly subdivided into 8 groups). Spores spherical. Calyptrae cucullate (or rarely mitrate).

1. Plants minute (rarely as high as 7 mm.), ephemeral; capsules immersed; operculum and peristome none — 1. *Pleuridium*
1. Plants larger (generally more than 1 cm. high), persistent; capsules exserted; operculum and peristome differentiated
  2. Leaves distichous, sheathing at base and abruptly narrowed to a long, slender, rough subula — 2. *Distichium*
  2. Leaves in many rows, not notably sheathing at base or abruptly narrowed to the acumen, smooth
    3. Leaves subtubulose above; margins erect; cells rounded or oblong-elliptic above — 5. *Ditrichum*
    3. Leaves keeled above; margins recurved below; upper cells subquadrate [see also species of *Ditrichum* outside the Straits region]
      4. Plants bluish-green or glaucous, autoicous; perichaetial leaves scarcely differentiated; capsules erect and symmetric, brownish, irregularly wrinkled-striate when dry; peristome teeth bifid nearly to the base, the forks not thickened or connected at the nodes — 4. *Saelania*
      4. Plants not bluish or glaucous, dioicous; perichaetial leaves broadly pointed and strongly sheathing; capsules strongly inclined, asymmetric, dark, purplish-red, sulcate; peristome teeth bifid nearly to the base, thickened and generally connected at the nodes below — 3. *Ceratodon*

## 1. **Pleuridium** Brid.

Very small, gregarious or loosely tufted ephemerals. Stems erect; simple or forked. Leaves usually erect-spreading or subsecund (or occasionally imbricate below a comal tuft), scarcely altered on drying, gradually or sometimes abruptly elongate toward the stem tip, mostly narrow and subulate, sometimes abruptly subulate from a broad base, the lower leaves sometimes differentiated and ovate-lanceolate; costa generally filling most of the awn and usually excurrent, at least in upper and perichaetial leaves; cells smooth, short to linear above, oblong-rhomboidal and rectangular below, not differentiated at the basal angles. Setae very short, erect; capsules immersed, subglobose or broadly ellipsoidal to ovoid, bluntly mucronate to apiculate or sometimes rostrate; operculum and peristome not differentiated. Spores spherical, brownish, papillose. Calyptrae cucullate or rarely mitrate, smooth.—The name means at the side because the short but curved seta of some species makes the sporophyte appear lateral in position.

**Pleuridium subulatum** (Hedw.) Rabh.—Plants in loose, yellow-green or yellow-brown tufts 3-7 mm. high. Leaves 1.5-4 mm. long, loosely erect or erect-spreading, rather gradually acuminate to subulate from an oblong or ovate base, channeled or subtubulose above; margins erect or incurved above, entire or ± sinuose-serrulate at the shoulders (or sometimes irregularly dentate at shoulders of upper and perichaetial leaves); costa filling most of the subula and percurrent or excurrent; cells firm-walled and linear or linear-flexuose above, oblong-rhomboidal or linear near the shoulders, rather laxly short- to long-rectangular at base. Autoicous and paroicous, sometimes on the same stems, the antheridia in small axillary buds, sometimes weakly 1-2-bracteate or even naked in axils of upper leaves. Setae 0.2-1 mm. long; capsules 0.8-1.1 × 0.5-0.7 mm., ellipsoidal (ovoid when immature), bluntly apiculate, light- or orange-brown, often shiny, stomatose at extreme base. Spores 24-41 $\mu$, pale-orange or orange-brown as seen in mass, finely papillose. Calyptrae cucullate.—n = 13, 26.

Breen, Mosses of Florida, Pl. 10, figs. 4-9. Conard, How to Know the Mosses, (ed. 2) figs. 102a-c, 102d (as *P. acuminatum*). Darlington, Mosses of Michigan, fig. 28. Grout, Mosses with Hand-lens and Microscope, fig. 31 (as *P. subulatum,* above, and *P. alternifolium,* below), Moss Flora of North America 1: Pl. 13C, figs. 1-2, figs. 3-4 (as *P. acuminatum*). Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 60. Welch, Mosses of Indiana, fig. 47.—**Fig. 191-194.**

A spring ephemeral (rarely found in summer), on soil in bare patches in second-year stubble fields and lawns, roadsides, pastures. Europe, North Africa, Asia, and Madeira; Nova Scotia to Minnesota, south to Florida and Texas; also in Arizona.

EMMET CO.—Brutus.

Because of variable sexual conditions, the paroicous *P. acuminatum* Lindb. can be included in *P. subulatum.* The single collection known from the Straits region is autoicous and, therefore, clearly *P. subulatum* by any definition.)

Mrs. Britton (The Observer, vol. 5-7. 1894-96) referred to the pygmy mosses (*Pleuridium, Phascum, Bruchia, Ephemerum,* and *Nanomitrium*) as brownies (an American equivalent of elves and pyxies, immortalized by Palmer Cox). Our "brownies" are ephemerals of weedy habitats. They are able to complete their short life cycles in the early spring and late fall when they escape competition from larger weeds dominating the habitats at other times. They are commonly found in the second year of old-field succession (the first year after cultivation) and not in subsequent years.

A natural hybrid between *Pleuridium subulatum* and *Ditrichum pallidum* (Hedw.) Hampe has been described (from Maryland) as **Pleuriditrichum marylandicum**, by Andrews and Hermann (Bryol. 62: 119-122. 1959).

**Pleuridium palustre** (Bruch & Schimp.) BSG, widely distributed in the East but not recorded from the Great Lakes area, may be autoicous or paroicous. The calyptra is mitrate, and the capsules are strongly apiculate or even shortly rostrate, with stomata just below the middle.

## 2. **Distichium** BSG

Slender but often elongate plants in dense, green, tomentose tufts. Leaves distichous, with an erect, oblong, sheathing base abruptly narrowed to a rough, spreading, linear subula; costa very rough, excurrent, filling most of the subula; lower cells linear or oblong-linear, smooth and pellucid; upper cells small, subquadrate or short-rectangular, green and obscure, roughened because of thickened cross-walls. Autoicous; perigonia axillary; perichaetial leaves not notably differentiated. Setae single, straight, elongate; capsules cylindric or ovoid-cylindric, erect and symmetric or strongly inclined and ± asymmetric, finely wrinkled when dry; annulus large, deciduous in fragments or ± persistent; operculum low-conic; peristome inserted somewhat below the mouth, dark- or red-brown, consisting of 16 equidistant, lanceolate teeth variously split or perforate, or of 8 groups of about 4 irregular, filiform divisions. Spores spherical. Calyptra cucullate, smooth, entire.—The name refers to the arrangement of leaves in two rows.

| | |
|---|---|
| Capsules cylindric, erect and symmetric; spores 16-25 $\mu$ | 1. *D. capillaceum* |
| Capsules ovoid-cylindric, horizontal and asymmetric; spores 32-48 $\mu$ | 2. *D. inclinatum* |

1. **Distichium capillaceum** (Hedw.) BSG—Plants 1-6 cm. high. Leaves (1.5)2.5-4.5 mm. long. Setae 8-18 mm. long, red or reddish-brown or sometimes yellowish; capsules 1-2 mm. long, cylindric, erect, brown; peristome teeth 16, equidistant, lanceolate, split or perforate nearly to the base into 2 ± equal divisions, finely papillose-roughened or nearly smooth except for faint, oblique striolations. Spores 16-25 $\mu$, densely and finely papillose-roughened.—n = 14, 28, 42.

Conard, How to Know the Mosses, (ed. 2) fig. 32a-c. Darlington, Mosses of Michigan. fig. 31. Grout, Mosses with Hand-lens and Microscope, fig. 34 (as *Swartzia montana*).—**Fig. 195-197.**

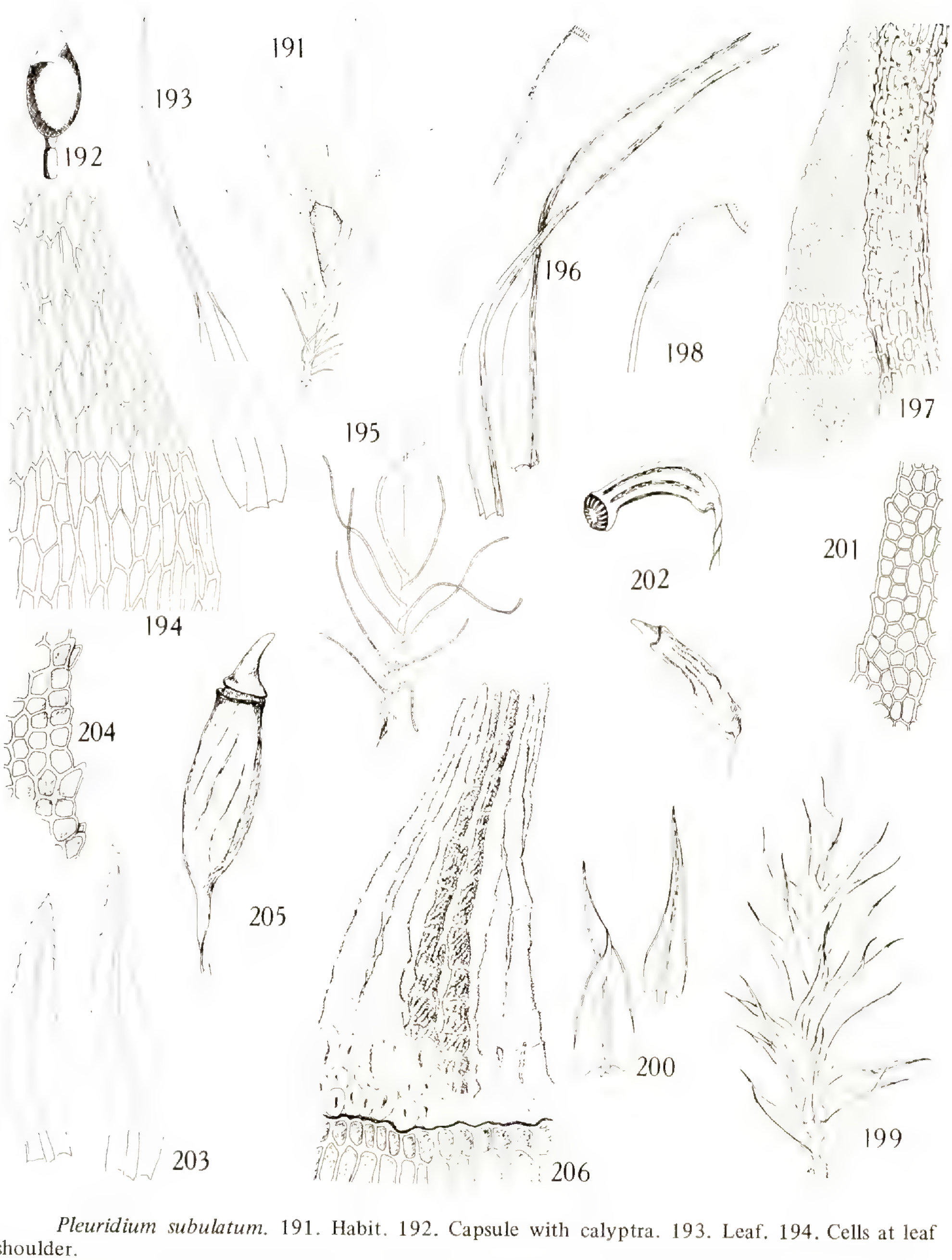
Typical of damp, shaded, calcareous rocks and cliffs, but also found on soil or humus, and sometimes on bark at base of trees or shrubs in *Thuja* swamps. In North America, from Alaska to Greenland, south to Colorado and Arizona in the West and New York to Iowa in the East; Mexico to Patagonia; New Zealand, Australia, and New Guinea; Europe and Asia.

CHEBOYGAN CO.—Iron Bridge. EMMET CO.—Cecil Bay, Big Stone Creek. MACKINAC CO.—Mackinac Island, Ozark. PRESQUE ISLE CO.—Evergreen Beach.

Very pretty, slender mosses in dense, soft, often silky tufts, easily known by distichous leaves with shiny, white, clasping bases contrasting with dull, rough, subulate points.

2. **Distichium inclinatum** (Hedw.) BSG—Plants 1.5-3 cm. high. Leaves 2-3 mm. long. Setae (7)12-20 mm. long; capsules 1-1.5 mm. long, horizontal, ovoid-cylindric, brown; peristome teeth 16, equidistant, lanceolate, divided by perforations into 2-3 narrow divisions, weakly oblique-striolate. Spores 32-48 $\mu$, densely and finely papillose-roughened.—n = 13, 14.

Grout, Moss Flora of North America 1: Pl. 18C.—**Fig. 198.**




*Pleuridium subulatum.* 191. Habit. 192. Capsule with calyptra. 193. Leaf. 194. Cells at leaf shoulder.

*Distichium capillaceum.* 195. Habit. 196. Leaves. 197. Cells above leaf shoulder.

*Distichium inclinatum.* 198. Capsule.

*Ceratodon purpureus.* 199. Habit. 200. Leaves. 201. Cells at margin of upper portion of leaf. 202. Young and old capsules.

*Saelania glaucescens.* 203. Leaves. 204. Cells at margin of upper part of leaf. 205. Dry capsule. 206. Portion of peristome.

Locally uncommon. On damp rocks and cliffs, also on soil or humus of sheltered banks; typically a calciphile. Europe and Asia; Alaska to Greenland, south to Montana and the Great Lakes and eastward to Newfoundland.

CHEBOYGAN CO.–Gorge of Carp Creek. EMMET CO.–Big Stone Creek

The shorter, horizontal, asymmetric capsules and much larger spores distinguish this from *D. capillaceum.* (The cylindric and symmetric capsules of *D. capillaceum* are occasionally somewhat inclined, causing possible confusion between the two species.)

### 3. **Ceratodon** Brid.

Rather small plants in dense, dull tufts, often forked. Leaves contorted when dry, lanceolate, gradually acuminate, usually acute, sometimes ± awned, keeled; margins usually strongly reflexed to revolute, notched or irregularly serrulate near the tip; costa subpercurrent to excurrent, prominent at back; cells subquadrate, thick-walled, and smooth above, short-rectangular below. Dioicous; perichaetial leaves differentiated, sheathing. Setae erect, elongate; capsules exserted, suberect and nearly symmetric to strongly inclined and asymmetric, ± strumose at base, ± sulcate when dry; annulus large and revoluble; operculum conic; peristome teeth 16, lanceolate, split nearly to the base into 2 terete divisions which are thickened and connected at the joints toward the base, bordered, papillose. Spores spherical. Calyptra cucullate, smooth, entire.–The name refers to the forked peristome teeth which resemble horns (of a goat, for example).

**Ceratodon purpureus** (Hedw.) Brid.–Plants 0.5-2.5 cm. high, dirty-green, yellow-brown, or reddish, often in dense tufts. Leaves 1.8-2 mm. long, acute or sometimes ± awned; margins strongly reflexed or revolute nearly to the apex, irregularly notched or serrulate near the tip; costa percurrent to excurrent; upper cells 7-9 $\mu$ wide. Perigonia swollen, conspicuous; perichaetial leaves elongate, erect and sheathing, the inner leaves obtuse or shortly and broadly pointed. Setae 8-30 mm. long, dark, purplish-red (or rarely ± yellow or orange); capsules 1.25-2 mm. long, ovoid-cylindric, inclined to horizontal, asymmetric, strumose at base, dark-red, deeply furrowed when dry; operculum about 0.5 mm. long. Spores 11-15 $\mu$, yellow or greenish-yellow, smooth or nearly so.–n = 13.

Conard, How to Know the Mosses, (ed. 2) fig. 127. Darlington, Mosses of Michigan, fig. 32. Grout, Mosses with Hand-lens and Microscope, figs. 36-37. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 6 (as *C. purpurascens*), (ed. 2) Pl. 10. Welch, Mosses of Indiana, fig. 49.–**Fig. 199-202.**

A weed, exceedingly common on sterile soil and sometimes rock or old wood, usually in dry, open, disturbed places, often on old roofs. Cosmopolitan, though largely replaced in tropical latitudes by closely related species, varieties, or forms.

CHEBOYGAN CO.–Douglas Lake, Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge (Carp Creek), Vincent Lake, Smiths Bog, Bryants Bog, Colonial Point, Ellis Township, Inverness Township, Duncan Bay, Little Lake 16, Weber Lake. EMMET CO.–Pellston, Brutus, Alanson, Maple River, Arnott Lake, Pleasantview Swamp, Pellston Hills, Stutsmanville, Carp Lake, Wycamp Lake, Cecil Bay. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Bay, St. Martins Point, McKays Creek, Gros Cap, Epoufette, Ozark, Prentiss Bay. PRESQUE ISLE CO.–Evergreen Beach, Hammond Bay, Huron Beach, Mast Point, Presque Isle lighthouse, Ocqueoc Falls, Rainy River Falls.

Surely no other moss causes the trouble in identification that *Ceratodon purpureus* does. Karl Müller (von Halle) said it was created to weary the bryologist! Its

sterile forms are protean and occasionally fool the most seasoned bryologist, because of characters more suggestive of the Pottiaceae (*Barbula,* for example) than the Ditrichaceae. To the practiced eye, however, the leaves present a microscopic appearance which is nearly unmistakable, because the margin is strongly reflexed or revolute nearly to the apex where it becomes irregularly notched or serrulate and also because of the characteristic squarish, firm, smooth upper cells. From descriptions *Bryoerythrophyllum recurvirostrum* might seem similar, but its leaves have papillose upper cells and large, lax, thin-walled basal cells.

The peristome is particularly beautiful. Its morphological development is described by Evans and Hooker (Bull. Torrey Bot. Club 40: 97-109. 1913). The annulus, of the revoluble type, is good for demonstration partly because the species is always available (being common, ubiquitous, and, in fact, a rank weed even in the smoggiest of cities) and also fruits freely.

Like many weeds, thriving in areas disturbed or even polluted by man, *Ceratodon* is a nitrophile, as evidenced also by its characteristic occurrence on sea cliffs on which birds roost or nest. It is also an early invader after fire. Its success as a pioneer on bare soils, in burned areas, for example, is partly owing to underground gemmae produced on rhizoids.

After burning, nitrogen, potassium, and iron are soon leached away, and more acid-loving species (such as *Polytrichum*) will replace the original invaders, such as *Ceratodon purpureus, Funaria hygrometrica,* and *Marchantia polymorpha.* According to Uggla (Acta Phytogeogr. Suec. 41: 1-116. 1958), *Ceratodon purpureus* occurs in great abundance in burned-over areas in northern Scandinavia, where it reaches a maximum after some decades and then declines rapidly. (In a 1933 burn, it was very common in 1945 and 1947 but rare in 1957.)—For further information on burns, see *Funaria hygrometrica, Buxbaumia aphylla, Pleurozium schreberi* and *Polytrichum juniperinum,* elsewhere in this book.

Gates (Bryol. 49: 66-71. 1946; Papers Mich. Acad. Sci., Arts & Lett. 37: 31-45. 1951) and Duncan (Mich. Bot. 12: 167-177. 1973) followed 40 years of succession on dry sandy soil once occupied by a laboratory building at Douglas Lake, Michigan. The area was first available for revegetation in 1930. *Ceratodon purpureus* was first noted in 1934. By 1940 it occupied 46% of the plot, and 94.5% by 1950. *Polytrichum juniperinum* appeared in 1942; by 1971 it and *P. piliferum* had almost entirely replaced *Ceratodon* and were accompanied by nine species of *Cladonia.* Leach (Jour. Ecol. 19: 98-102. 1931) also found species of *Polytrichum* following *Ceratodon* on British sands. According to Watson (*Structure and Life History of Bryophytes*), burned soils in Great Britain may be pioneered by *Funaria* and later succeeded by *Ceratodon, Polytricha,* and lichens. (*Funaria,* like *Marchantia,* favors wet soils. *Ceratodon* grows equally well on wet or dry, sterile or fertile soils.)

Unlike *Ceratodon,* most mosses are restricted in distribution, both ecologically and geographically, even though their spores may be exceedingly numerous and easily wafted about by winds. Ingold (Trans. Proc. Bot. Soc. Edinb. 38: 76-88. 1959) estimated the number of spores produced by four capsules of *Eurhynchium confertum* as 280,000, 480,000, 500,000, and 700,000. Kreulen (Jour. Bryol. 7(1): 61-74. 1972) made the following computations (of spores per capsule):

| | | | |
|---|---|---|---|
| *Archidium alternifolium* | 1-20 | *Grimmia pulvinata* | 200,000 |
| *Atrichum undulatum* | 450,000 | *Hypnodendron auricomum* | 1,500,000 |
| *Brachythecium rutabulum* | 400,000 | *Hypopterygium* cf. *tenellum* | 240,000 |
| *Buxbaumia aphylla* | 5,500,000 | *Leucobryum glaucum* | 80,000 |
| *Ceratodon purpureus* | 120,000 | *Mnium hornum* | 120,000 |
| *Dawsonia lativaginata* | 80,000,000 | *Ochrobryum kunzeanum* | 22,500 |
| *Dicranella heteromalla* | 80,000 | *Orthodontium lineare* | 70,000 |
| *Eurhynchium confertum* | 210,000 | *Orthotrichum cupulatum* | 470,000 |
| *Funaria hygrometrica* | 350,000 | *Phascum cuspidatum* | 5,500 |

| | | | |
|---|---|---|---|
| *Physcomitrium pyriforme* | 9,000 | *Rhacopilum spectabile* | 600,000 |
| *Pohlia nutans* | 150,000 | *Schistostega pennata* | 36,000 |
| *Polytrichum formosum* | 2,200,000 | *Tortula muralis* | 1,000,000 |
| *P. piliferum* | 1,400,000 | (and, from capsules of different size | |
| *Pottia truncata* | 7,500 | and habitat, 500,000-700,000) | |

It can be seen, by comparing *Ceratodon* with *Buxbaumia,* for example, that the number of spores is not necessarily correlated with abundance of individuals or their overall distributions. The factors controlling distributions of spore-bearing plants, including dispersal mechanisms, are discussed by Crum (Jour. Hattori Bot. Lab. 35: 269-298. 1972).

## 4. **Saelania** Lindb.

Rather small plants, bluish-green and glaucous because of a very fine, whitish, mealy, and filamentous covering on the leaves. Leaves somewhat contorted when dry, erect or erect-spreading when moist, narrowly lanceolate, gradually acuminate, keeled; margins irregularly (and often doubly) serrate in the upper ½, often on both surfaces, usually ± reflexed at least below the middle; costa percurrent or shortly excurrent, prominent and ± toothed at back; upper cells subquadrate or short-rectangular, smooth, firm-walled, usually bistratose here and there along the margins (and sometimes elsewhere). Autoicous; perigonia terminal on well-developed branches; perichaetial leaves not much differentiated. Setae erect, elongate; capsules cylindric, erect and symmetric, irregularly wrinkled-striate when dry; annulus of 2-3 rows of large, pale cells, persistent; operculum rostrate; peristome teeth 16, inserted near the mouth, split nearly to the base into 2 terete forks, densely papillose. Spores spherical. Calyptra cucullate, smooth, entire.—Named for a Finnish botanist, Anders Thiodolf Saelan.

**Saelania glaucescens** (Hedw.) Bom. & Broth.—Rather small plants (0.4-1.5 cm. high). Leaves 1-2.5 mm. long, ± reflexed in the lower half or more; costa percurrent or shortly excurrent; upper cells 10-11 $\mu$ wide, subquadrate or short-rectangular, bistratose in spots (with occasional cells projecting as teeth). Setae 4-13 mm. long; capsules 1.5 to 2.5 mm. long, yellow or yellow-brown; operculum rostrate, about 0.8-1 mm. long; peristome teeth red-brown. Spores 16-20 $\mu$, finely papillose.—n = 13.

Darlington, Mosses of Michigan, fig. 33. Grout, Moss Flora of North America 1: Pl. 18F.—**Fig. 203-206.**

On soil (often calcareous), typically on steep banks, particularly in the protection of overhanging turf, frequent at roadsides, also on rocks or soil in rock crevices. Europe, Asia, New Zealand; Greenland to Alaska and south to Arizona, Colorado, Iowa, Michigan, and New York.

CHEBOYGAN CO.—Lake bluff near Bryants Bog and on bank of road on Grapevine Point and in "Manville" on the campus of the Biological Station (all at Douglas Lake).

The remarkable bluish cast of the plants is unmistakable. The leaf structure is similar to that of *Ceratodon,* although one would scarcely confuse the two genera. The plants are pretty when growing, but dried specimens are likely to seem infected with a mold which is actually a cobwebby covering normal to the leaves and accounting for their waxy bloom.

## 5. **Ditrichum** Hampe

Rather small, loosely tufted plants, simple or forked. Leaves lanceolate or ovate-lanceolate, mostly gradually acuminate or subulate, often curved and sometimes

secund; costa subpercurrent to excurrent, the lamina narrow above and sometimes absent above the shoulders; upper cells subquadrate to linear, smooth (or very rarely ± papillose); lower cells usually oblong to linear. Perichaetial leaves not much differentiated but sometimes enlarged and clasping at base. Setae elongate, erect or flexuose; capsules cylindric or ellipsoidal, suberect or inclined, often curved and asymmetric and frequently ± striate or furrowed when dry and empty; annulus large, compound, revoluble or ± persistent; operculum conic or conic-rostrate; peristome inserted near the mouth, the teeth 16, usually split to the low basal membrane into 2 filiform, terete, usually papillose divisions, suberect, or somewhat oblique or weakly spiraled. Spores spherical. Calyptrae cucullate, smooth, entire.–The name refers to the peristome teeth, each usually consisting of two hair-like divisions.

**Ditrichum flexicaule** (Schwaegr.) Hampe–Plants in yellow-brown or dark-green, dull or sometimes ± shiny tufts 1.5-6 or more cm. high, usually ± tomentose below, often repeatedly forked, occasionally (in reduced forms) bearing stiffly erect branches with ovate-lanceolate, erect leaves. Leaves 2-7 mm. long, erect-spreading and flexuose (and sometimes moderately twisted at the apex when dry, sometimes contorted or circinate), lanceolate, gradually long-acuminate, subtubulose above, usually irregularly serrate at and occasionally below the tip, smooth at back; costa subpercurrent to rather long-excurrent; cells smooth and incrassate throughout, rounded or oblong-elliptic and dark-green above; basal cells variable, subquadrate to shortly rhomboidal in reduced forms with short leaves, oblong to linear in larger plants, a few marginal cells at the shoulders nearly always obliquely short-rhomboidal and somewhat paler forming a suggestion of a border. Dioicous. Setae 8-25 mm. long, dark-red, somewhat flexuous; capsules 1.5-2 mm. long, cylindric, erect and symmetric or nearly so, only slightly wrinkled or furrowed when dry and empty, chestnut-brown; operculum 0.7-0.9 mm. long, high-conic or conic-rostrate, blunt; peristome teeth bifid nearly to the basal membrane, densely papillose or spiculose, light-brown at base, whitish above. Spores 9-11 $\mu$, smooth or nearly so, yellowish in mass.

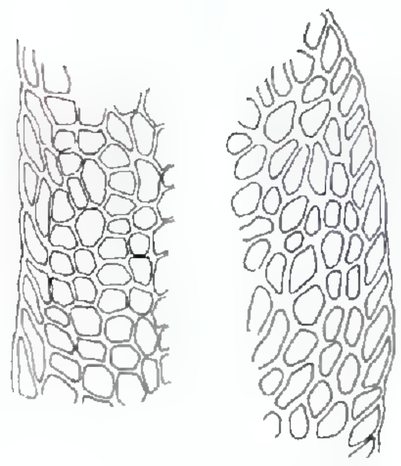
Darlington, Mosses of Michigan, fig. 35. Grout, Moss Flora of North America 1: Pl. 29A, 30A (left).–**Fig. 207-209.**

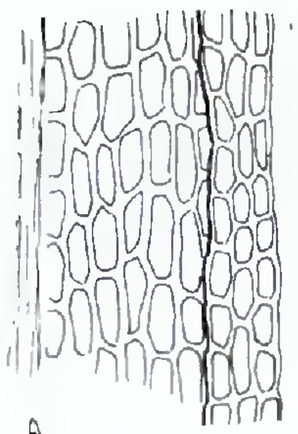
An indicator of basic conditions extremely common in the North and in the Rocky Mountains, typically on cliffs but also common on soil; locally on calcareous sand along the shores of Lake Michigan and Lake Huron. Circumpolar; Guatemala and Colombia; New Zealand; across North America south to Vermont, Michigan, Iowa, and Colorado.

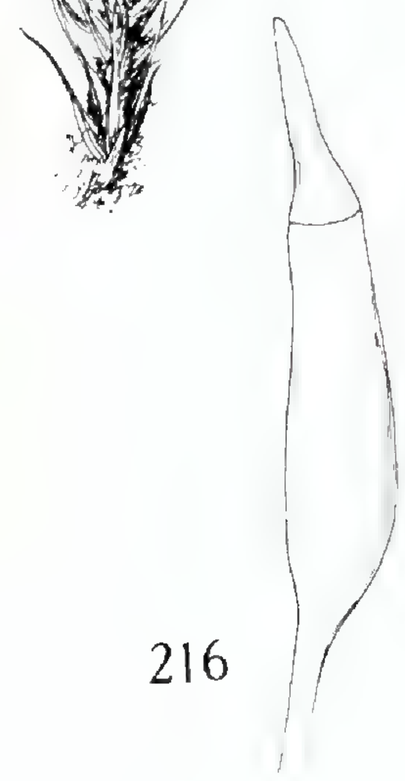
CHEBOYGAN CO.–Duncan Bay. EMMET CO.–Cecil Bay. MACKINAC CO.–Mackinac Island, Bush Bay. PRESQUE ISLE CO. -Mast Point, Hammond Bay, Evergreen Beach, Hoeft State Park.

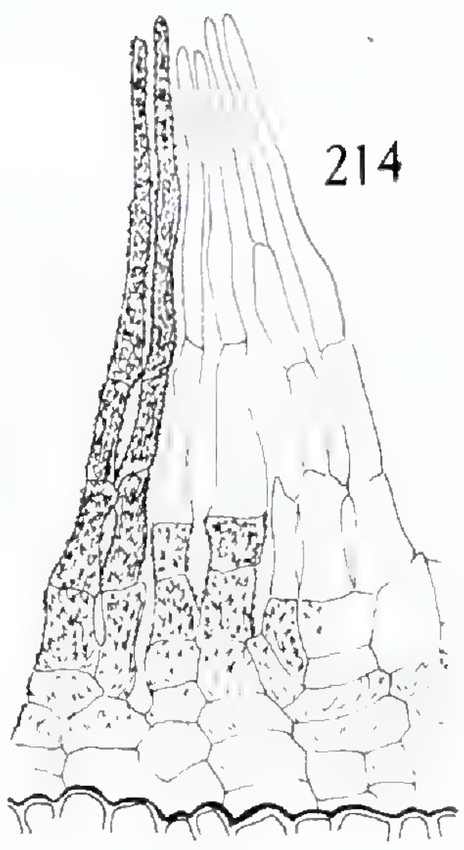
This species of extraordinary variability can be recognized by small, dark upper leaf cells with thick walls and rounded ends and by a subtle border of short, oblique cells at the leaf shoulders. Small plants having short leaves with the costa only slightly excurrent have been called the var. *densum* (BSG) Braithw.; this form frequently produces stout, erect, somewhat reduced branches (somewhat like those of *Dicranum flagellare*). Robust plants of moist habitats (especially on cliffs) with long, flexuose, ± twisted leaves with long-excurrent costae have been given a variety of names, including var. *sterile* De Not. and, most appropriately, *D. giganteum* Williams. These two extremes, completely intergrading, are directly related to conditions of moisture and exposure. All our material can be assigned to *D. flexicaule*, in the typical sense, or to the var. *densum*.

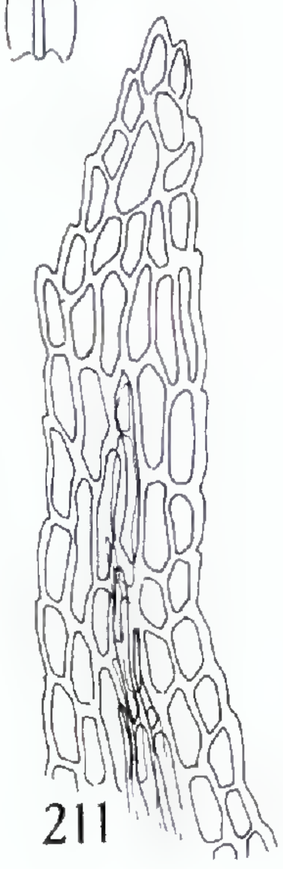
*Ditrichum lineare* (Sw.) Lindb. (found in Chippewa County on roadside sand at Trout Lake and on Sugar Island) is smaller and bears straight innovations with crowded










*Ditrichum flexicaule.* 207. Habit. 208. Leaf. 209. Cells at margin of shoulders of two leaves.
*Ditrichum pusillum.* 210. Leaves. 211. Cells of leaf tip. 212. Cells at margin of upper median portion of leaf. 213. Capsule. 214. Portion of peristome.
*Ditrichum pallidum.* 215. Leaves. 216. Capsule (moist).

and imbricate, blunt, cucullate leaves; the leaf cells are linear and often bistratose in spots along the margins. It is probably an acidophile. Also found on Sugar Island (and elsewhere in the state) is *D. pusillum* (Hedw.) Hampe, which has chronically suffered from confusion with *D. lineare.* In **D. lineare**, the plants normally bear straight, terete innovations with short, blunt, cucullate, appressed leaves. The leaf margins are entire or nearly so, plane (or rarely somewhat recurved in places), and not thickened. The leaf cells are linear. The peristome teeth are rather finely papillose and irregularly split by perforations into two coherent divisions. In **D. pusillum** (fig. 210-214), the plants are sometimes forked but do not produce especially differentiated innovations. The leaf margins are irregularly thickened and serrulate and also recurved. The leaf cells are subquadrate to short-rectangular. The peristome teeth, split nearly to the base into two usually free divisions, are obliquely striolate and often rather lightly papillose as well. Both species are found as pioneers on roadbanks of sandy or silty soil. Chromosome numbers reported for *D. lineare* are n = 14, for *D. pusillum,* n = 13, 13+1, 14.

**Ditrichum pallidum** (Hedw.) Hampe (fig. 215-216), common in southern Michigan and southward in oak-hickory woodlands, is best recognized by its long, slender, yellow setae (n = 13). **Ditrichum rhynchostegium** Kindb. has an orange-yellow seta. It differs also in having the costa not quite filling the leaf subula and therefore narrowly margined by short cells, and its spores are smaller (only 11-13 $\mu$) and nearly smooth.

**Trichodon cylindricus** (Hedw.) Schimp. is a rare western disjunct known from Mt. Bohemia in Keweenaw County. Like a *Ditrichum* in most respects, the plants are small and slender and have leaves abruptly narrowed from a sheathing base to a wide-spreading, linear, roughened subula largely filled by the costa.

## DICRANACEAE

Plants small to large, usually in dense, often radiculose tufts. Stems erect, simple or forked. Leaves in many rows, often falcate-secund, mostly narrowly long-lanceolate and often subulate; costa single and usually strong, ending near the apex to excurrent; upper cells variously shaped, smooth or rarely mammillose or papillose; lower cells elongate, often clearly differentiated at the basal angles. Setae mostly elongate; capsules erect or inclined, sometimes asymmetric; operculum nearly always differentiated, typically ± obliquely rostrate from a conic base; peristome teeth usually present and well developed, mostly lanceolate and usually deeply split into 2(3) divisions, mostly vertically pitted-striolate below. Calyptra cucullate.

1. Alar cells clearly differentiated
   2. Leaves consisting almost entirely of costa, in cross-section showing a median layer of green cells enclosed dorsally and ventrally by hyaline cells (and sometimes with green cells mingled with the dorsal hyaline cells); stereids lacking — 5. *Paraleucobryum*
   2. Costa narrower, consisting of median guide cells and 2 stereid bands — 4. *Dicranum*
1. Alar cells scarcely differentiated
   3. Neck of capsules very long and narrow (at least as long as the urn); peristome teeth vertically barred below — 2. *Trematodon*
   3. Neck not conspicuously differentiated; peristome teeth pitted-striolate below
      4. Leaves abruptly narrowed from a strongly sheathing base to a wide-spreading subula, strongly crisped and curled when dry; autoicous — 3. *Oncophorus*
      4. Leaves gradually or abruptly narrowed, mostly not sheathing at base, not much contorted when dry; dioicous — 1. *Dicranella*

### 1. **Dicranella** Schimp.

Small plants in loose, green, yellowish, or brownish tufts. Stems sparsely radiculose below, becoming forked by innovation. Leaves usually small below, larger and more crowded above, erect-flexuose to secund, narrowly lanceolate or subulate, gradually tapered from a narrow, nonsheathing base or ± abruptly narrowed and ± squarrose from a broad, obovate, sheathing base; costa subpercurrent to excurrent; cells smooth, subquadrate to linear in the upper median region, larger and oblong toward the insertion, not differentiated at the basal angles. Dioicous; perichaetial leaves usually similar to the upper stem leaves, sometimes more sheathing at base. Setae single, elongate, erect or flexuose; urn of capsule erect or inclined, symmetric or asymmetric, sometimes strumose, smooth or furrowed, subglobose to oblong-cylindric; annulus lacking or present, often compound; operculum long-rostrate, inclined or curved; peristome teeth 16, sometimes short and irregular but usually well developed and divided about ½ way down into 2 papillose forks, nearly always vertically pitted-striolate below. Spores spherical.–The name meaning little *Dicranum* derives from some resemblance to that genus in the appearance of the leafy plants, especially in species with secund leaves.

1. Setae yellow; capsules suberect, furrowed when dry and empty and contracted below the strongly oblique mouth — 2. *D. heteromalla*
1. Setae reddish; capsules curved and inclined, smooth (or somewhat plicate), not notably oblique at the mouth or contracted below it

2. Leaves erect-spreading or secund, gradually narrowed from a lanceolate base to a linear-lanceolate point, bistratose and irregularly recurved at the margins 3. *D. varia*

2. Leaves flexuose-spreading or squarrose from an obovate, sheathing base and gradually narrowed from the shoulders to a lanceolate point; margins plane and unistratose

3. Leaves acute; margins entire except at the extreme apex; median cells 7-9 $\mu$ wide 1. *D. schreberiana*

3. Leaves usually blunt; margins bluntly and irregularly serrulate to serrate; median cells 11-15 $\mu$ wide 1a. *D. schreberiana* var. *robusta*

1. **Dicranella schreberiana** (Hedw.) Schimp.–Plants small, yellowish, in cushions 5-20 mm. high. Leaves up to 2.5 mm. long, with a flexuose-spreading to squarrose limb, abruptly narrowed from an ovate to obovate, sheathing base, acute; margins plane and entire or sometimes ± toothed at the extreme tip; costa percurrent, becoming slightly excurrent in upper and perichaetial leaves, sometimes ± toothed at back near the tips, about 60 $\mu$ wide at base; cells distinct, thin-walled, rectangular or rather irregular, the upper median 7-9 $\mu$ wide, 2-3:1. Seta red, 7-12(25) mm. long; capsule curved and nodding, asymmetric, usually somewhat strumose, irregularly ribbed or occasionally smooth, 0.8-1 mm. long; annulus none; operculum long-rostrate, curved, equal to the urn; peristome teeth 400-455 $\mu$ high, forked less than ½-way from the tip. Spores smooth, greenish-yellow, 14-18 $\mu$.–n = 14, 15.

Conard, How to Know the Mosses, (ed. 2) fig. 132 (as *D. schreberi*). Grout, Moss Flora of North America, 1: Pl. 37 middle and lower left (*D. schreberi* & *D. grevilleana*).

On wet soil (often clay) on banks of roads, ditches, and streams. Circumpolar; Alaska to New Brunswick, south to New Jersey and the Great Lakes region.

EMMET CO.–Cecil Bay. MACKINAC CO.–Mackinac Island. PRESQUE ISLE CO.–Mast Point, Evergreen Beach.

At least some of the local material could be referred to **D. grevilleana** (Brid.) Schimp. because of clearly striate capsules, but the variation in this and other characteristics are such that I cannot recognize *D. grevilleana* as distinct from *D. schreberiana.*

1a. Var. **robusta** Schimp. *ex* Braithw.–Rather robust, yellow, tufted plants 0.5-5.5, rarely 8 cm. high. Leaves 1-3 mm. long, not crowded, laxly squarrose from an obovate, sheathing base, gradually narrowed from the shoulders and tapered to a blunt or acute apex; margins plane, bluntly and irregularly serrulate to serrate; costa 25-50 $\mu$ wide near the base, percurrent, nearly always ± toothed at back near the tip; upper median cells very distinct, large and rectangular, 11-15 $\mu$ wide, about 3:1. Seta red or reddish-yellow, 9-11 mm. long; urn about 1 mm. long, not plicate or strumose, rather broad in proportion to length; peristome teeth 360 $\mu$ high. Spores 13-16 $\mu$, smooth or nearly so.

On wet soil in roadside ditches and in creek beds. Europe; British Columbia and Alberta; Maine to Ontario, south to Michigan and New York.

CHEBOYGAN CO.–Douglas Lake, Gorge of Carp Creek, Point Nipigon. EMMET CO.–Maple River at Brutus Road. MACKINAC CO.–Bois Blanc Island. PRESQUE ISLE CO.–Hammond Bay.

Smooth capsules and leaves with gradually tapered bases, blunt points, strongly serrate margins, and shorter, broader cells characterize the variety.

2. **Dicranella heteromalla** (Hedw.) Schimp.–Small plants in yellow to dark-green, rather shiny tufts 1 (rarely up to 4) cm. high. Leaves erect to falcate-secund, 2-3 mm.

long, gradually narrowed from a lanceolate base to a subula largely filled by the costa; margins erect, serrulate in the upper half of the limb; costa excurrent, about 100 $\mu$ wide near the insertion, about 1/3 the width of the leaf base; cells in 1-3 rows above the middle of the leaf, rather short-rectangular, 4-7 × 11-14 $\mu$. Setae 5-15 mm. long, yellowish; capsules 1-1.5 mm. long, inclined to horizontal or more often suberect, cylindric, often curved, asymmetric, when dry usually furrowed and contracted below the oblique mouth; annulus consisting of 1 row of small, persistent cells; operculum 1 mm. long, long-rostrate; peristome 400-450 $\mu$, divided about ½ way down. Spores 14-18 $\mu$, very minutely roughened.—n = 11, 12+1, 13, 13+2-3, 14.

Conard, How to Know the Mosses, (ed. 2) fig. 131. Darlington, Mosses of Michigan, fig. 38. Grout, Mosses with Hand-lens and Microscope, fig. 39 & Plate 11. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 7, (ed. 2) Pl. 11. Welch, Mosses of Indiana, fig. 53, 54 (as var. *orthocarpa*).—**Fig. 217-218.**

On soil in disturbed places, especially on roadbanks and along trails in hardwood forests, sometimes on low mounds caused by windthrows. Circumpolar; northern South America; Alaska to California; Newfoundland to Manitoba, south to the Gulf of Mexico.

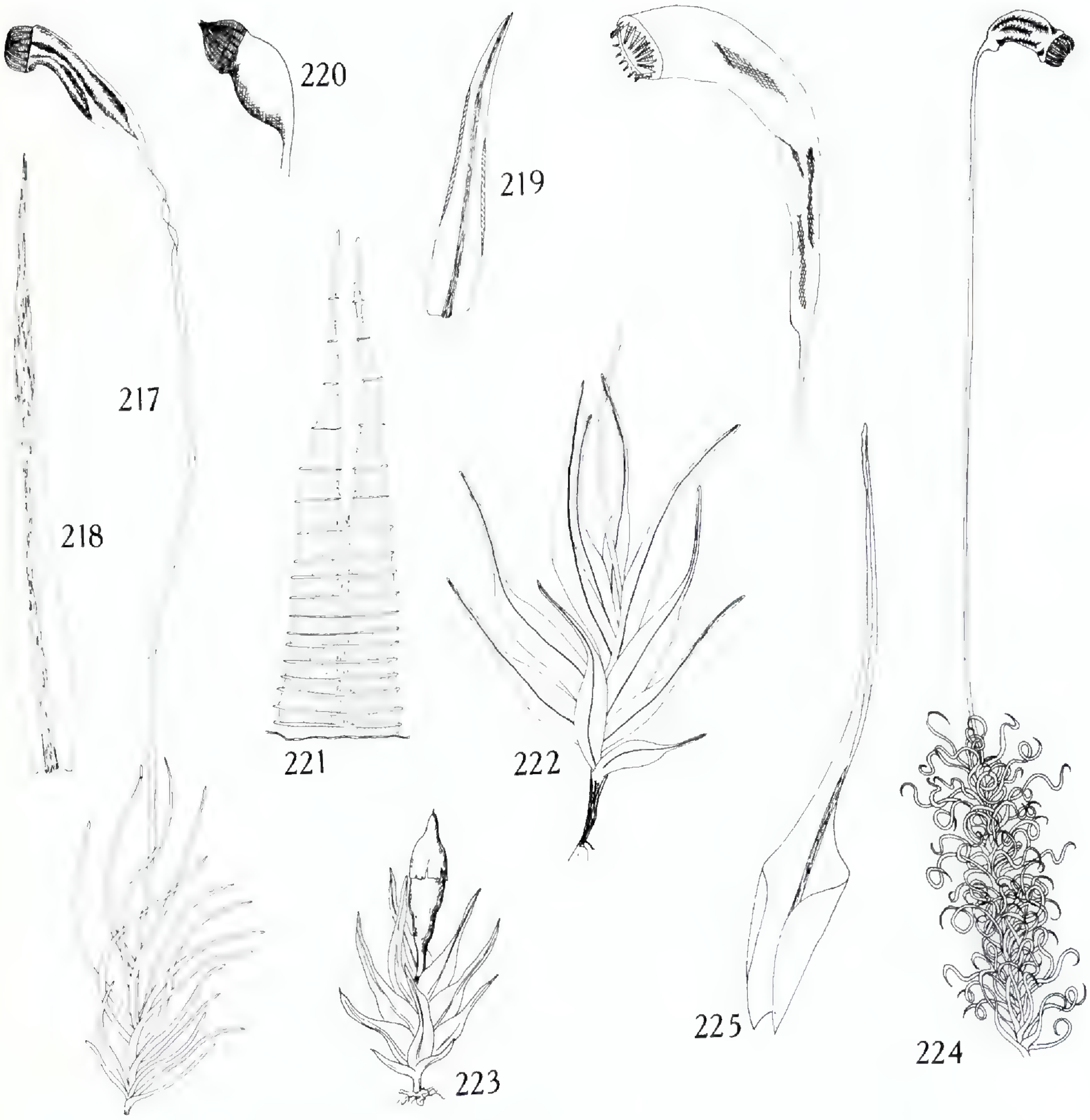
CHEBOYGAN CO.—Grapevine Point, Colonial Point, Vincent Lake, Lancaster Lake, Munro Lake, Mud Lake, Mullett Lake, Little Lake 16. EMMET CO.—Pellston Hills, Cross Village. MACKINAC CO.—Cut River, Ozark, Hendricks. PRESQUE ISLE CO.—Lamprey Experiment Station, Posen.

The setaceous leaves and the shape of the empty capsules, with somewhat oblique furrows, tapering neck, and very oblique mouth (appearing chucked under the chin), are distinctive.

**Dicranella cerviculata** (Hedw.) Schimp., known from nearby Alpena, Luce, and Alger Counties, is characterized as follows: Small plants with leaves erect-spreading and ± flexuose or secund, narrowly lance-subulate, acute or ± blunt; margins plane, entire or slightly serrulate at the tips; costa about ½ the leaf base; upper cells long-rectangular (5-10:1). Setae yellowish; capsules nodding, asymmetric, strumose, becoming furrowed when dry and empty; annulus of 1 row of cells

**Dicranella subulata** (Hedw.) Schimp., which has been found in the Upper Peninsula, has stem leaves lance-subulate; costa long-excurrent; cells long-rectangular (6-10:1); perichaetial leaves abruptly subulate from a sheathing base and flexuose-spreading to squarrose; seta reddish; capsules inclined, asymmetric but not strumose, furrowed; annulus compound.

3. **Dicranella varia** (Hedw.) Schimp.—Small plants in dull, dirty- to light-green or yellowish tufts 6-15 mm. high. Leaves erect-spreading or ± falcate-secund, about 1 mm. long below, becoming as much as 2 mm. long above, gradually narrowed from a lanceolate base to a linear-lanceolate, ± keeled limb, blunt or acute at the narrow, irregularly denticulate tip; margins bistratose and irregularly recurved above the basal portion of the leaf, entire except at the extreme tip; costa percurrent, about 45-60 $\mu$ wide near the insertion, 1/5-1/4 the width of the leaf base; upper median cells oblong-linear, 5-10 × 40-50 $\mu$, mostly about 6-9:1. Setae 5-8(16) mm. long, reddish; urn of capsule 0.7-1 mm. long, asymmetric, short-ovoid, variable in the same collections, sometimes erect but usually inclined to horizontal and curved, smooth, not strumose, contracted below the mouth; annulus none; operculum 0.5-0.7 mm. long, stoutly rostrate; peristome teeth 360-410 $\mu$ long, divided about 1/3 down. Spores 14-20 $\mu$, indistinctly roughened.—n = 14, 15.




*Dicranella heteromalla.* 217. Habit. 218. Leaf.
*Dicranella varia.* 219. Leaf. 220. Capsule. 221. Peristome tooth (taken from an unpublished drawing by Ethel Hutchinson).
*Trematodon ambiguus.* 222. Habit, with dry capsule (detached, upper right).
*Bruchia flexuosa.* 223. Habit.
*Oncophorus wahlenbergii.* 224. Habit. 225. Leaf.

Grout, Mosses with Hand-lens and Microscope, Pl. 13. Jennings, Mosses of Western Pennsylvania (ed. 1) Pl. 7, (ed. 2) Pl. 11. Welch, Mosses of Indiana, fig. 52.–**Fig. 219-221.**

On disturbed, calcareous soil (especially clay), on moist banks of ditches and along roads, in open situations. Circumpolar; Alaska to Nova Scotia, south to California and the Gulf of Mexico. Cuba, Jamaica, Haiti; Mexico and Guatemala.

CHEBOYGAN CO.–Colonial Point, Point Nipigon, Mill Creek, Cheboygan, Duncan Bay. MACKINAC CO.–Mackinac Island, Nunns Creek. PRESQUE ISLE CO.–Mast Point, Posen.

The short, oval, and asymmetric capsules with disproportionately large teeth provide a means of quick identification. Microscopically this species is recognized by the narrowly recurved margins on at least some leaves of each plant, usually more obvious along the shoulders. The median cells are long and narrow, 6-9:1, and the upper margins bistratose.

## 2. **Trematodon** Mx.

Plants small, gregarious to loosely tufted, light-green or yellowish. Stems erect, usually simple. Leaves ± contorted when dry, oblong-ovate and clasping at base, gradually to abruptly narrowed to a lanceolate or subulate point; costa subpercurrent to excurrent; cells smooth, small and obscure, subquadrate or short-rectangular, longer at base, not differentiated at the basal angles. Setae elongate, erect, yellow; capsules erect or somewhat curved, cylindric, the slender, conspicuous neck as long as the urn or longer, often strumose at base; annulus simple or compound; operculum slenderly and obliquely long-rostrate; peristome lacking or single, with 16 undivided, perforate, or forked teeth, vertically barred on the outer surface. Calyptra smooth, moderately inflated.–The name refers to the perforate peristome teeth. The outstanding feature of the genus is the long neck of the capsule and the odd sculpturing of the peristome.

**Trematodon ambiguus** (Hedw.) Hornsch.–Stems 4-7 mm. high. Leaves 2.5-5 mm. long, oblong and clasping at base, very abruptly contracted to a long awn, erect and entire at the margins, blunt at the tip; costa filling the awn; cells of the leaf base lax and yellowish, narrowly long-rectangular to rhomboidal, shorter and broader at the shoulders. Autoicous. Setae slender, bright-yellow (5)11-20(27) mm. long; capsules light-brown, the urn 1-2.5 mm. long, the neck usually about as long as or slightly longer than the urn, strumose at base; operculum 1-1.5 mm. long; annulus compound and revoluble; peristome teeth 270-310 $\mu$ high, perforate or forked nearly to the low, well-developed basal membrane, with vertical bars below and fine papillae at the pale tips. Spores 23-30 $\mu$, subreniform, papillose.

Conard, How to Know the Mosses, (ed. 2) fig. 125e. Darlington, Mosses of Michigan, fig. 30. Grout, Mosses with Hand-lens and Microscope, fig. 38, Moss Flora of North America 1: Pl. 26B. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 72.–**Fig. 222.**

On moist soil along roads and on banks of ditches or streams in more or less open, disturbed situations. Europe; eastern Asia; British Columbia; Newfoundland to Michigan and New York.

CHEBOYGAN CO.–Colonial Point. MACKINAC CO.–McNamara Pond.

This species has been called the LONG-NECKED MOSS in reference to its most striking feature. The bright yellow setae are particularly noticeable in the field.

**Trematodon longicollis** Mx., a more easterly species found once in southern Ontario, is distinguished by a much longer neck of the capsule and gradually tapered leaves with the costa not filling the subula and margins more or less recurved and bluntly serrulate above.

The genus *Bruchia* might be expected in ephemeral situations such as old fields during the winter and spring. **B. flexuosa** (Sw. *ex* Schwaegr.) C. M. (Fig. 223) has been found in southern Michigan. It is a pygmy moss with erect capsules emergent or barely exserted and shortly pyriform in shape because of the broad, tapered neck which is about as long as the rest of the capsule. (The shape is suggestive of an observation balloon.) The capsules are indehiscent, lacking an operculum and, of course, a peristome.

## 3. **Oncophorus** (Brid.) Brid.

Plants in dense, dull, green to yellow-brown tufts, somewhat radiculose below. Leaves usually strongly crisped when dry, lanceolate and gradually acuminate with an

erect base or linear-subulate from an obovate, clasping base; margins usually ± toothed; costa narrow, subpercurrent to slightly excurrent, with 2 stereid bands; upper cells small, subquadrate or short-rectangular, smooth, generally bistratose at least at the margins; lower cells rectangular to linear, firm- to thick-walled, the alar cells not or very poorly differentiated. Autoicous; perigonia axillary; perichaetial leaves not much differentiated. Setae single, elongate, erect; urn of capsule cylindric, curved and asymmetric, strumose at base, inclined to horizontal, mostly weakly furrowed when old and empty; annulus none; operculum obliquely rostrate, ± stout, shorter than the urn; peristome teeth 16, inserted at the mouth, red, lanceolate, split about ½ way down, vertically pitted-striolate nearly to the tips. Spores spherical. Calyptra smooth, entire at base.—The name refers to a goiter-like swelling at the base of the capsule.

**Oncophorus wahlenbergii** Brid.—Plants in light or yellowish-green tufts. Leaves (3)5-6 mm. long, strongly crisped and curled when dry, obovate or oblong and clasping at base, not decurrent, abruptly narrowed to a long-linear (rarely broader), flexuose, subtubulose subula; margins erect (or rarely slightly recurved), ± serrulate near the tip or as much as ½ way down, usually bistratose above (sometimes indistinctly so); costa percurrent or somewhat excurrent, often somewhat roughened at back above; upper cells quadrate to short-rectangular, sometimes quite thick-walled; cells of the sheathing base pale, rectangular to linear with firm to incrassate walls; alar cells not noticeably differentiated. Seta 8-15(21) mm. long, yellowish (sometimes becoming reddish); capsule 1-2 mm. long, strongly inclined to horizontal or sometimes cernuous, strumose at base, moderately furrowed when old or occasionally nearly smooth; operculum usually about 1 mm. long; peristome conspicuously red. Spores 14-30 $\mu$, green, smooth or nearly so.—n = 12+2, 14.

Conard, How to Know the Mosses, (ed. 2) fig. 115. Darlington, Mosses of Michigan, fig. 42. Grout, Mosses with Hand-lens and Microscope, fig. 35. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 8, (ed. 2) Pl. 12—**Fig. 224-225.**

Typically on moss-covered, rotten logs in moist forests. Circumpolar; Greenland to Alaska, south to British Columbia, Colorado, Michigan, and New York.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge (Carp Creek), Livingston Bog, Duncan Bay, 3 miles north of Cheboygan, Grass Bay. EMMET CO.—Arnott Lake, Maple River, Pleasantview Swamp, Carp Lake, Cecil Bay, Conway Bog. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, Epoufette, Ozark, McNamara Pond. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Clinton Lake.

A beautiful moss growing in small, green tufts. The leaves are strongly crisped and contorted when dry, and the pale capsules, with a curious goiter at base, offer a striking contrast to the Fuchsia-red peristome. The species is often confused with *O. virens* (Hedw.) Brid., which occurs in Michigan but not in our area: *Oncophorus wahlenbergii* has leaves distinctly clasping at the oblong or obovate base and abruptly narrowed to a subtubulose acumen; the leaf margins are plane (or rarely indistinctly revolute at the middle). **O. virens** has leaves erect but not clasping at base, ovate-lanceolate, and gradually narrowed to the acumen which is keeled (and, when dry, folded); the leaf margins are distinctly revolute near the middle.

## 4. **Dicranum** Hedw.

Plants small to large, in dense, ± tomentose tufts. Stems simple or forked. Leaves generally lanceolate (rarely ovate), gradually acuminate, keeled or subtubulose, usually secund, sometimes crisped when dry, not bordered (but occasionally bistratose at margins); costa well developed, narrow, ending near the apex to shortly excurrent, with

2 stereid bands, often ridged and serrate at back; cells smooth or papillose, elongate, incrassate, and porose throughout or short and unpitted above and usually elongate and ± porose below; alar cells well differentiated, usually yellow-brown near the margins but hyaline within. Dioicous; male plants similar to the female plants or dwarfed and growing on the tomentum or leaves of female plants, minute and bud-like or sometimes somewhat elongate with as many as 3 perigonial buds; perichaetial leaves convolute-sheathing, abruptly subulate. Setae elongate, slender, erect; capsules long-exserted, cylindric, ± asymmetric, nearly straight and suberect to curved and inclined or horizontal, ± furrowed when dry and empty, not or slightly strumose; operculum long-rostrate; peristome teeth 16, inserted at or near the mouth, lanceolate, split 1/2 or 2/3 down into 2 or rarely 3 rather unequal divisions, red-brown or brown, vertically pitted-striolate below, papillose at the pale tips. Spores spherical, finely and indistinctly papillose. Calyptra smooth, entire at base.—The name refers to the forked nature of the peristome teeth. The vertically pitted-striolate peristome teeth and differentiated alar cells are other generic features. Secund or contorted leaves are characteristic of most of the species. One of the "FORK MOSSES"—perhaps *Dicranum elongatum* Schleich.—is reported in Franklin's *Journey to the Polar Sea* (Appendix, 1824) as growing in dense cushions called "WOMEN'S HEADS" by Arctic-American natives because "when you kick them they never get out of the way." (None of the *Dicrana* are so densely tufted or so troublesome.)

1. Upper leaf cells elongate and porose; annulus none
 2. Leaves wide-spreading, strongly undulate; margins broadly recurved on 1 or both sides; costa with 2 serrate ridges at back; setae clustered 4. *D. polysetum*
 2. Leaves erect and typically falcate-secund, not or very slightly undulate; margins not recurved; costa with 4 serrate ridges at back; setae single 5. *D. scoparium*
1. Upper cells short, not or indistinctly porose; annulus present
 3. Leaves fragile, bistratose above 1. *D. viride*
 3. Leaves not fragile, unistratose (or occasionally ± bistratose at margins)
  4. Leaves concave or subtubulose above
   5. Plants not bearing brood branches; leaves broadly ovate at base, gradually narrowed to a broad acumen; capsules inclined and asymmetric 8. *D. spurium*
   5. Plants bearing small brood branches in axils of upper leaves; leaves slender and acuminate; capsules nearly erect and symmetric
    6. Brood branches stout, rigid and terete, with small, ovate, appressed leaves; leaf cells smooth 3. *D. flagellare*
    6. Brood branches weak and slender, with linear, spreading, greatly contorted leaves (the plants usually consisting almost entirely of such branches); leaf cells ± mammillose at back 2. *D. montanum*
  4. Leaves ± keeled above
   7. Leaves not undulate; margins bistratose above (sometimes indistinctly or only in patches); male plants large 7. *D. fuscescens*
   7. Leaves usually ± undulate above; margins unistratose; male plants dwarfed and resting on the leaves or tomentum of female plants
    8. Leaves erect, not much contorted when dry, clearly undulate above, broadly acute or obtuse; costa ending somewhat below the apex 10. *D. undulatum*
    8. Leaves spreading and ± contorted when dry, not or only slightly undulate, acuminate; costa percurrent to slightly excurrent
     9. Leaves strongly contorted when dry; leaf cells in conspicuous longitudinal rows separated by well-marked pellucid lines; setae mostly clustered 6. *D. drummondii*
     9. Leaves curved or somewhat crisped when dry; leaf cells less conspicuously in rows; setae single 9. *D. sabuletorum*

1. **Dicranum viride** (Sull. & Lesq.) Lindb.—Rather small plants in dull, dark-green to yellowish-brown, ± tomentose tufts 1.5-3.5 cm. or less high. Leaves erect-spreading, flexuose, occasionally ± falcate-secund, about 5-6.5 mm. long, gradually long-acuminate, ending in a linear, deciduous point which is usually yellowish and glassy-looking, channeled above, entire or only occasionally very slightly serrulate near the apex; costa up to ¼ the leaf base, 90-150 $\mu$ wide near the base, long-excurrent,

completely filling the deciduous leaf tip; upper cells mostly subquadrate, 8-10 $\mu$ wide, bistratose and obscure, smooth; lower cells short-rectangular, thick-walled, ± colored; alar cells extending to the costa, brownish at the margins. Male and female plants similar. Seta 10-17 mm. long; urn 2.5-3 mm. long, erect and symmetric, cylindric, smooth or obscurely furrowed when dry and empty; annulus of mostly 2 irregular rows of larger cells, persistent; operculum 1.25-2 mm. long. Spores 16-21 $\mu$.

Conard, How to Know the Mosses, (ed. 2) fig. 58d (as *D. fulvum* var. *viride*). Grout, Mosses with Hand-lens and Microscope, fig. 48. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 9, (ed. 2) Pl. 13 (as *D. fulvum* var. *viride*). Welch, Mosses of Indiana, fig. 58.–**Fig. 226-227.**

On the bark of trees, especially near the base. Circumpolar; Nova Scotia to Minnesota, south to Iowa, Michigan, and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Sedge Point, Livingston Bog, Colonial Point, Mud Lake, Black Lake. EMMET CO.–Arnott Lake, Galloway Bog, Pleasantview Swamp, Pellston Hills, Cross Village, Middle Village, Five Mile Creek, Conway Bog, Ramona Beach. MACKINAC CO.–Bois Blanc Island, Mackinac Island, Epoufette, Ozark, Hendricks. PRESQUE ISLE CO.–Evergreen Beach, Rainy River Falls.

**Dicranum fulvum** Hook. has been needlessly confused with this species. It is larger, coarser, brownish-green to yellow-brown, and grows on granitic or siliceous rocks (and therefore not to be expected in our area). *D. viride* is green, grows on bark, and has fragile leaf tips which are smooth and entire or nearly so, longer basal cells, and a narrower costa.

**Dicranum fragilifolium** Lindb., a rare species found on Isle Royale and elsewhere in the Lake Superior region, has fragile leaves which are pale green to yellow, shiny and scarcely contorted when dry, with longer, oblong-linear basal cells. The male plants are dwarfed; and the capsules are curved and inclined.

2. **Dicranum montanum** Hedw.–Plants very small to moderate in size, in dense, brown, yellow-brown or more often dark-green, dull, tomentose tufts 0.5-3 cm. high, often bearing small, strongly crisped leaves on short, weak branches near the apex but more frequently consisting almost entirely of such branches. Leaves not secund, strongly crisped when dry, 2-3.5 mm. long (or in reduced forms, only 0.4-0.5 mm.), narrowly lanceolate and gradually acuminate, acute, ± rough at back above, concave but usually not particularly subtubulose above, serrulate about ½ down; costa percurrent or shortly excurrent; upper cells 8-11 $\mu$, subquadrate, obscure, ± mammillose at back; lower cells oblong and incrassate; alar cells brown to hyaline, rather poorly differentiated. Male and female plants similar. Seta 6-14 mm. long; urn 1.5-1.75 mm. long, erect but usually slightly curved, slightly furrowed when dry; annulus deciduous in fragments, consisting of 1-2 irregular rows of large cells; operculum 1.2-1.5 mm. long. Spores 16-21 $\mu$.–n = 12, 14.

Grout, Moss Flora of North America, 1: Pl. 44E. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 8, (ed. 2) Pl. 12. Welch, Mosses of Indiana, fig. 55.–**Fig. 228.**

Very common on rotten logs, stumps, and bark of trees, particularly on their bases or exposed roots. Circumpolar; British Columbia to Newfoundland, south to Arkansas and South Carolina; Arizona.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Iron Bridge, Maple River, Colonial Point, Vincent Lake, Livingston Bog, Mud Lake, Grass Bay. EMMET CO.–Arnott Lake, Maple River Township, Pellston Hills, Stutsmanville, Cross Village, Middle Village, Five Mile Creek, Ramona Beach, Cecil Bay, Big Stone Creek. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Cut River, Epoufette, Ozark, Hendricks. PRESQUE ISLE CO.–Evergreen Beach, Hammond Bay, Mast Point, Ocqueoc River, Rainy River Falls, Clinton Lake.

*Dicranum montanum* occurs as a scurfy, dull, dark-green growth on bark at the base of trees and sometimes on rotten wood. It is related to *D. flagellare,* but it is much smaller and instead of producing stout, axillary branchlets with short, appressed leaves, it bears weak branchlets with strongly crisped and spreading, roughened leaves differing from those of ordinary stems mainly in size. Generally whole colonies of this moss appear to consist of such leafy branchlets or of plants reduced and resembling them).

3. **Dicranum flagellare** Hedw.–Plants in compact, dull, green or brownish tufts (0.5)1-3(5.5) cm. high, tomentose below, nearly always bearing in the axils of upper leaves clusters of stout, stiff, terete branchlets with minute, appressed leaves. Leaves 2-3 mm. long, falcate-secund or equally spreading and moderately crisped when dry, lance-acuminate or sometimes ovate-lanceolate (rarely ovate), acute to obtuse (or rarely broad and rounded at the tips), strongly subtubulose above, serrulate at margins and ± rough at back above; costa percurrent or slightly excurrent; upper cells mostly subquadrate, 8-11 $\mu$ wide, smooth, rather thick-walled; lower cells rectangular and elongate; alar cells well differentiated, usually brownish, scarcely extending to the costa. Seta 10-20 mm. long; urn 2-3 mm. long, erect, straight or nearly so, irregularly furrowed when dry; annulus of 2 irregular rows of cells, ± deciduous; operculum 1.2-2 mm. long. Spores 14-16(21) $\mu$.–n = 12, 23.

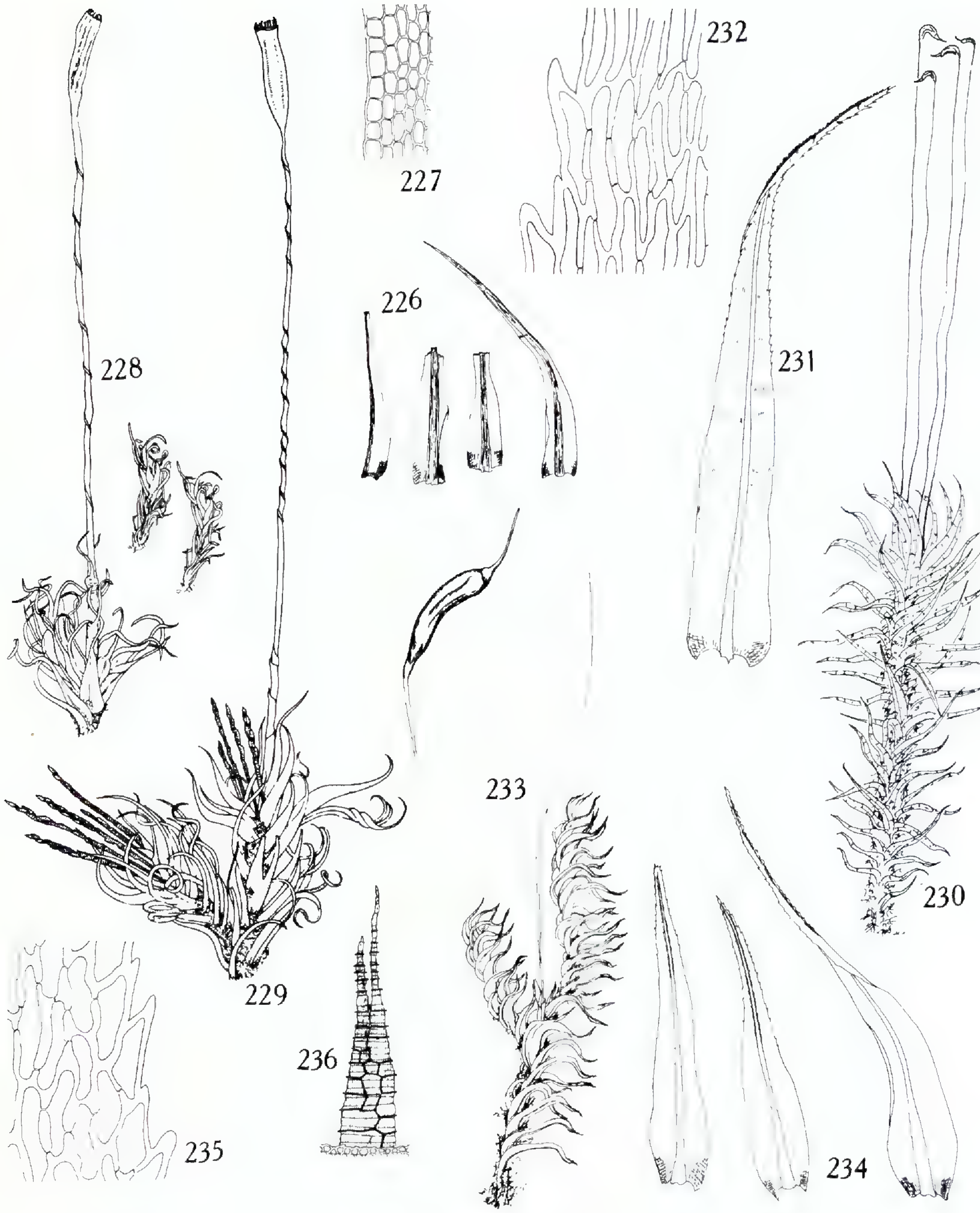
Conard, How to Know the Mosses, (ed. 2) fig. 119. Grout, Mosses with Hand-lens and Microscope, fig. 46c, c′ d, Moss Flora of North America 1: Pl. 44D. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 8, (ed. 2) Pl. 12. Welch, Mosses of Indiana, fig. 56.–**Fig. 229.**

Very common in the Straits region on rotten logs and stumps, rarely on humic soil. Circumpolar; British Columbia to Newfoundland, south to Louisiana and Florida; Mexico.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Gleasons Bog, Vincent Lake, Wolffs Bog, Livingston Bog, Mud Lake, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.–Arnott Lake, Galloway Bog, Pleasantview Swamp, Wycamp Lake, Five Mile Creek. MACKINAC CO.–Bois Blanc Island, McKays Creek, Cut River, Epoufette, Ozark, Little Dollar Lake. PRESQUE ISLE CO.–Lamprey Experiment Station, Evergreen Beach, Ocqueoc River, Kelsey Pond, Loon Lake.

Easily recognized by subtubulose leaves and axillary branchlets with short, appressed leaves. The branchlets, too stout and stiff to be considered flagellate, as the name suggests, are usually produced in great numbers. When too few to be seen easily, they can be detected in the field by gently rubbing them off in the palm of one's hand. Similar branchlets are produced in other genera of Dicranaceae, in species of *Holomitrium* and *Campylopus,* for example.)

4. **Dicranum polysetum** Sw.–Plants large, in light-green to golden, usually glossy, densely tomentose tufts 2-15 cm. high. Leaves spreading and flexuose, rarely secund, not much altered when dry, 8-10 mm. long, lanceolate, gradually long-acuminate, acute, keeled and ± folded when dry, usually undulate, sharply toothed on the margins and at back of the costa about ½ down, with margins ± broadly recurved below the middle on 1 or both sides; costa very narrow, vanishing below the apex, with 2 serrate ridges at back (the teeth on each ridge in 1 or rarely 2 rows); cells elongate and porose throughout, smooth; alar cells clearly differentiated, golden-brown. Male plants dwarfed. Setae usually clustered, 1-5(7) per perichaetium, 20-37 mm. long; urn 2.5-4 mm. long, strongly curved and inclined to horizontal, asymmetric, furrowed when dry and empty, not strumose; annulus none; operculum 2.5-4 mm. long. Spores 16-27 $\mu$.–n = 10+1, 11, 12, 12+1, 13, 13+1, 14.




*Dicranum viride*. 226. Leaves. 227. Cells of upper part of leaf.
*Dicranum montanum*. 228. Habit of sterile and fruiting plants.
*Dicranum flagellare*. 229. Habit.
*Dicranum polysetum*. 230. Habit. 231. Leaf. 232. Upper cells of leaf.
*Dicranum scoparium*. 233. Habit. 234. Leaves. 235. Cells of upper portion of leaf. 236. Peristome tooth.

Conard, How to Know the Mosses, (ed. 2) fig. 116e-f (as *D. rugosum*). Grout, Mosses with Hand-lens and Microscope, fig. 46a, a′ (as *D. undulatum*), Moss Flora of North America 1: Pl. 43I (as *D. undulatum*). Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 61 (as *D. rugosum*).–**Fig. 230-232.**

Very common on humus, sometimes on soil (often on thin soil or humus over rocks), in more or less shaded, dry and moist woods. Circumpolar; Yukon to Nova Scotia, south to Washington, Missouri, Kentucky, and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Carp Creek, head of Gorge of Carp Creek, Iron Bridge, Burt Lake, Pine Point, Bryants Bog, Livingston Bog, Mud Lake, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.–Arnott Lake, Pleasantview Swamp, Stutsmanville, Galloway Bog, Cecil Bay, Big Stone Bay, Waugoshance Point, French Farm Lake, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Prentiss Bay, Hog Island Point, Epoufette, Ozark, Hendricks, Peggley Lake. PRESQUE ISLE CO.–Presque Isle lighthouse, Huron Beach, Mast Point, Lamprey Experiment Station, Evergreen Beach, Clinton Lake.

Our largest and showiest Dicranum. The leaves glisten because of undulations which reflect light like a rippled mirror. The clustered sporophytes and wide-spreading leaves with long, porose cells are among many well-marked differences between this and *D. undulatum,* a bog species with undulate leaves called *D. bergeri* Bland. in most books. It is unfortunate that, for nomenclatural reasons, the name *D. undulatum* goes with a less common, less undulate species, and both *D. undulatum* and *D. rugosum,* so suitably applied to this species in the past, must give place to *D. polysetum.*

Mrs. Britton (The Observer 6: 18. 1895) commented that the *Dicrana* always seem to be fruited and abundantly so. She related this phenomenon (true of some but not all our members of the genus) to the fact that the plants grow in dense tufts that present an appearance of crowded abundance and also that the cycle from fertilization to spore dispersal takes 17 to 22 months, with the result that overlapping stages of development add to an illusion of abundance. Such an overlap is exemplified by many mosses, of course, because of a predominance of species of perennial growth.

It goes without saying that mosses that are monoicous–with both sexes on the same plants–have the best chance of accomplishing fertilization and forming sporophytes. All the *Dicrana* are dioicous, but those which fruit most commonly may be thought of as functionally monoicous, as the male plants are minute buds resting on the tomentum or leaves of the much larger female plants. Such a dwarf-male, quasi-autoicous condition facilitates fertilization and provides the genetic advantages of outbreeding, lacking in a truly autoicous situation. Dwarf male plants are easily demonstrated in *Dicranum polysetum, D. scoparium, D. drummondii, D. sabuletorum,* and *D. undulatum.* These are the species in our flora that fruit in abundance.

An unpublished dissertation by Loveland on "Sexual Dimorphism in the Moss Genus *Dicranum* Hedw." presents the view that dwarf males in *Dicranum* result from a chemical influence of female plants on spores, rather than a chromosomal or genetic factor. Wallace (Abstr. XI International Botanical Congress, p. 232. 1969, and "Developmental Morphology and Sexual Dimorphism . . . , 1970) found that in *Camptothecium megaptilum* the majority of male plants are reduced and epiphytic on older leaves of female plants: Only one male plant in 200 was large and independent in occurrence, but spores germinated in culture all developed into large plants, and dwarf males removed from the leaves of female plants became transformed into large plants. She concluded that there is a hormonal control of sexuality but also thought that a slight differentiation of spores into size classes suggests incipient heterospory. Other discussions of sexual dimorphism (and the differentiation of sex chromosomes and anisospores sometimes associated with such dimorphism) include Allen (Proc. Amer. Phil. Soc. 58: 289-316. 1919), Dening (Flora 30: 57-86. 1935-36), Ernst-Schwarzenbach (Verh. Schweiz. Naturf. Ges. Solothurn 1936: 310-311. 1936 and Ann. Bryol. 11: 46-55. 1938), Fleischer (Ber. Deutsch. Bot. Ges. 38: 84-92. 1920), Miyoshi (Hikobia 3: 294. 1963), Khanna (The Nucleus 14: 14-23. 1971), Ramsay (Bryol. 69: 293-311. 1966), Vitt (Mich. Bot. 7: 195-202. 1968), and Woesler (Planta 24: 1-13. 1935). Epiphytic dwarf male plants have been found in a Japanese species of Mniaceae, *Mnium minutulum* Besch. (Koponen, Hikobia 6: 47. 1971).–See also discussions of sexuality in *Eurhynchium pulchellum* and *Pleurozium schreberi,* elsewhere in this book.

Reviews of the genetics of bryophytes were presented by Allen (Bot. Rev. 1: 269-291. 1935, and 11: 260-287.

Maturation cycles in mosses present a fertile field for investigation. Published reports indicate that mosses of temperate regions require about six to 20 months to complete the maturation of sporophytes (most species falling in the range of seven to 15 months). Papers on phenology and especially maturation cycles include Arnell (Bryol. 8: 41-44. 1905), Barkman (Buxbaumia 15: 21-30. 1961), Benson-Evans & Brough (Trans. Cardiff Nat. Soc. 92: 4-23. 1966), Briggs (New Phytol. 64: 366-386. 1965), Clarke & Greene (Trans. Brit. Bryol. Soc. 6(1): 114-128. 1970 and 6(2): 278-295. 1971), Forman (Bryol. 68: 289-300. 1965), Greene (Trans. Brit. Bryol. Soc. 3: 736-745. 1960), Grimme (Hedwigia 42: 1-75. 1903), Longton (Bull. Brit. Antarct. Surv. 10: 85-95. 1966, 27: 51-96. 1972), Longton & Greene (Phil. Trans. Roy. Soc. London, B, 252: 295-322. 1967 and Ann. Bot. 33: 83-105. 1969), Towle (Bryol. 8: 44-45. 1905; 9: 54-56. 1906; 11: 53-54. 1908), Towle & Gilbert (Bryol. 7: 35-36. 1904), and van der Wijk (Buxbaumia 14: 25-39. 1960). Newton (Jour. Linn. Soc. London, Bot. 65: 189-209. 1972) studied the effect of photoperiod on some aspects of the life cycle.

5. **Dicranum scoparium** Hedw.—Plants usually coarse and fairly robust, in glossy, yellowish or green or sometimes dull, dirty-green or brownish tufts (1)2-8(12) cm. high, densely tomentose. Leaves exceedingly variable, typically falcate-secund, but often erect-spreading or sometimes appressed, not much altered on drying, sometimes slightly undulate, 3.5-8(12) mm. long, narrowly or broadly lanceolate, gradually acuminate, narrowly to broadly acute, ± keeled above, rarely subtubulose, typically strongly serrate in the upper 1/3; costa 75-120 $\mu$ wide near the base, ending near the apex to slightly excurrent, typically strongly (2)4-ridged at back and serrate above; cells smooth, elongate and porose throughout (sometimes relatively broad and obscurely porose), often linear and more elongate; alar cells well differentiated, yellow-brown, not extending quite to the costa. Male plants usually dwarfed but rarely large and similar to the female plants. Setae single (rarely paired), 18-35 mm. long; urn 2-3.5 mm. long, ± curved, suberect to horizontal, nearly smooth or somewhat furrowed when old; annulus none; operculum 2.5-3 mm. long, often longer than the urn. Spores 14-24 $\mu$.—n = 10, 10+1, 11, 12, 12+1, 13, 14.

Conard, How to Know the Mosses, (ed. 2) fig. 117a-d. Grout, Mosses with Hand-lens and Microscope, fig. 42a, a′, 43, 44b, Moss Flora of North America 1: Pl. 46C. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 8, (ed. 2) pl. 12. Welch, Mosses of Indiana, fig. 60.—**Fig. 233-236.**

Very common throughout the Straits region on various substrata, but typically on soil in dry to rather moist forests. Circumpolar; Australia and New Zealand; Greenland to Alaska and south to California, Colorado, Louisiana, and Florida.

CHEBOYGAN CO.—Douglas Lake, Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Colonial Point, Grass Bay, Weber Lake. EMMET CO.—Arnott Lake, Pleasantview Swamp, Carp Lake, Wilderness State Park, Cecil Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Prentiss Bay, Cut River, Epoufette, Ozark, Little Dollar Lake. PRESQUE ISLE CO.—Presque Isle lighthouse, Mast Point, Clinton Lake.

Often called the BROOM MOSS, owing to secund leaves which give the tufts a swept appearance. The elongate, porose leaf cells and costa with four serrate ridges at back (or rarely and atypically only two) are characteristic features of the species. In *D. polysetum*, the costa has only two ridges at back of the costa.

Although the name is occasionally useful in an ecological context, **Dicranum bonjeanii** De Not. *ex* Lisa, in North America at least, is no more than a pigeon-hole for convergent forms of *D. scoparium* and *D. polysetum* with rather broadly pointed, erect, shiny leaves. Plants which could be referred there have been found on sand among jackpines near the shore of Lake Huron at Evergreen Beach (Presque Isle Co.).

Large forms of *D. scoparium* are often confused with **D. majus** Sm., a species of more oceanic climes, the Canadian Maritime Provinces, for example. It has setae in clusters, leaves up to 12 mm. long, and upper leaf cells in bistratose streaks above, forming indistinct, intramarginal borders of inconspicuous ridges toward the apex. It does not have the well-developed serrate ridges at the back of the costa so characteristic of *D. scoparium*.

6. **Dicranum drummondii** C. M.—Rather robust plants in dull, green or yellow-brown tufts 4-8 cm. high, densely rusty-tomentose below. Leaves flexuose-spreading and sometimes ± secund, strongly contorted when dry, 5-9 mm. long, lanceolate, gradually long-acuminate, acute, strongly keeled and ± undulate above, sharply serrate in the upper 1/2 or 2/3, plane-margined; costa 115-150 $\mu$ wide just above the alar region, subpercurrent to very slightly excurrent, serrate and densely papillose at back above, distinctly ridged at back, usually laterally spurred; upper cells 7-10(14) $\mu$, subquadrate or short-rectangular, small and dark, only moderately incrassate, in ± regular longitudinal rows, usually ± papillose at back, some cells usually projecting as scattered teeth at the undulations; lower cells elongate, slightly porose; alar cells yellow-brown, not extending to the costa. Male plants dwarfed. Setae usually clustered, 1-3 per perichaetium, 20-27 mm. long; capsules 2-2.5 mm. long, horizontal, strongly curved and asymmetric, furrowed, not strumose; annulus of 2 rows of cells, fragmenting; operculum 2.5-3 mm. long. Spores 14-23 $\mu$.

Conard, How to Know the Mosses, (ed. 2) fig. 60a-c. Grout, Mosses with Hand-lens and Microscope, fig. 46b, b′, Moss Flora of North America 1: Pl. 48A (fig. 1), 50C.—**Fig. 237-238.**

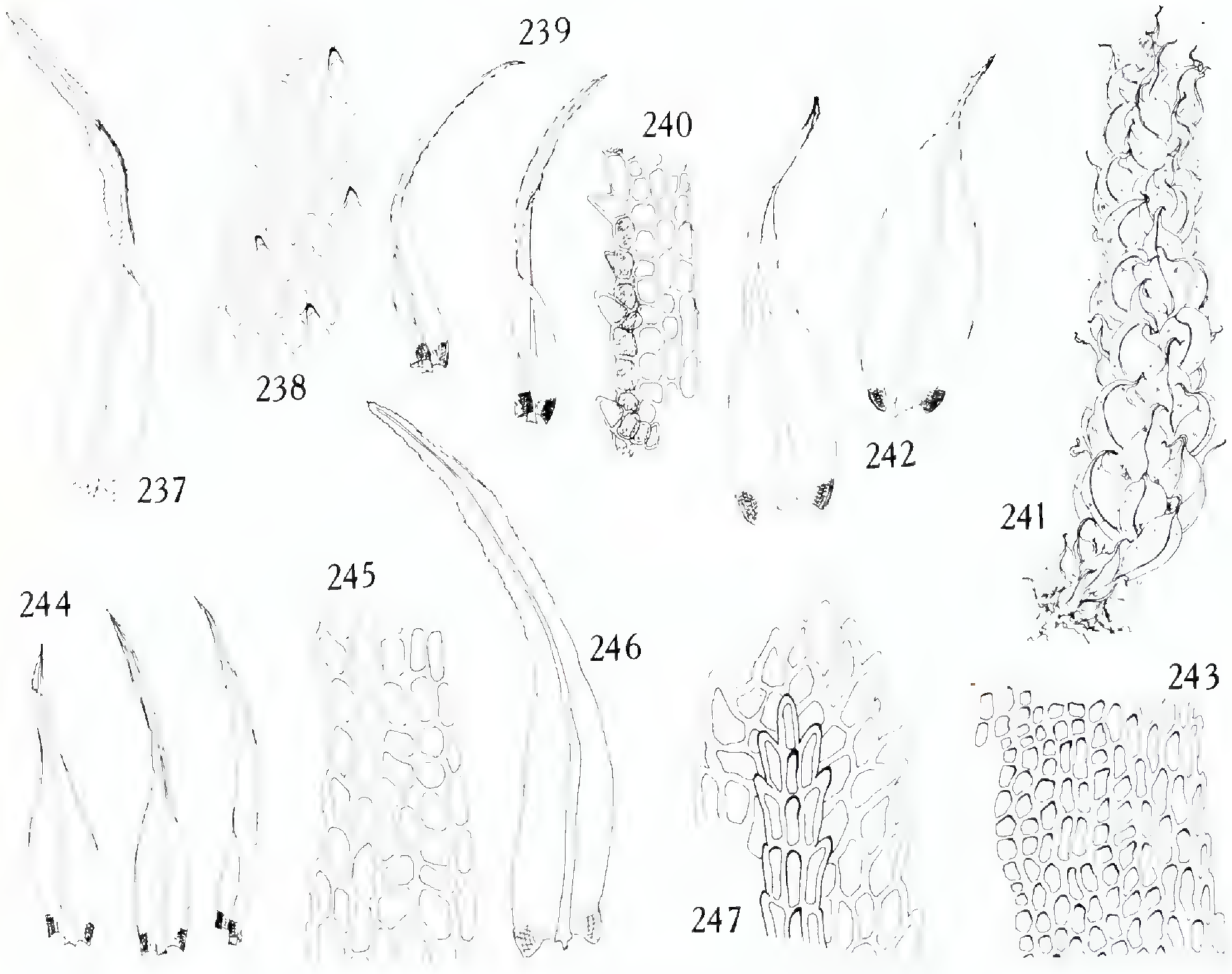
On humus, rarely on rotten wood, in dry coniferous forests, such as jackpine barrens, rarely in aspens. Endemic to North America; Alberta and Montana to Newfoundland, south to Wisconsin, Ohio, and North Carolina.

CHEBOYGAN CO.—Reeses Bog, head of Gorge of Carp Creek, Iron Bridge, Bryants Bog. EMMET CO.—Stutsmanville, Cecil Bay, Big Stone Bay, Conway Bog. PRESQUE ISLE CO.—Evergreen Beach.

Unmistakable in typical form, this species may sometimes be difficult to distinguish from forms of *D. undulatum* or *D. sabuletorum*. The clustered setae, woolly stems, and wide-spreading leaves with points contorted and incurved when dry aid in recognition.

7. **Dicranum fuscescens** Turn.—Dull, green or brownish plants in ± tomentose tufts 2-4 (rarely 10) cm. high. Leaves falcate-secund (or sometimes flexuose-spreading), often ± crisped when dry, 4-7 mm. long, narrowly lanceolate, gradually and slenderly acuminate, acute, somewhat keeled above; margins serrulate about ½ down, bistratose above (sometimes indistinctly so or only in patches); costa 100-200 $\mu$ wide near the base, shortly excurrent, usually serrulate at back about ½ way down; upper cells 8-12 $\mu$ wide, subquadrate or short-rectangular, smooth or occasionally papillose at back, usually in ± regular longitudinal rows; lower cells rectangular and usually ± pitted; alar cells yellow-brown, not extending to the costa. Male plants large. Setae 8-20 mm. long; capsules 1.75-3 mm. long, inclined or horizontal, curved and asymmetric, ± furrowed and often somewhat strumose when dry; annulus of 1-2(3) irregular rows of large, pale cells, ± persistent; operculum 2-2.5 mm. long. Spores 16-32 $\mu$.—n = 9, 10, 10+1, 12, 24.

Conard, How to Know the Mosses, (ed. 2) fig. 59a-d, 120a-d. Grout, Mosses with Hand-lens and Microscope, figs. 42b, b′, c, 44c, Moss Flora of North America 1: Pl. 46E.—**Fig. 239-240.**




*Dicranum drummondii.* 237. Leaf. 238. Upper cells of leaf.
*Dicranum fuscescens.* 239. Leaves. 240. Upper cells at leaf margin.
*Dicranum spurium.* 241. Habit. 242. Leaves. 243. Upper cells of leaf.
*Dicranum sabuletorum.* 244. Leaves. 245. Upper cells of leaf.
*Dicranum undulatum.* 246. Leaf. 247. Cells at apex of leaf.

A forest species, on rotten logs or stumps and less commonly on bark of exposed roots or tree bases. Circumpolar; Greenland to Alaska, south to California, Colorado, Michigan, and Tennessee.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Iron Bridge, Livingston Bog. EMMET CO.–Arnott Lake, Pleasantview Swamp, Stutsmanville, Big Stone Bay. MACKINAC CO.–McKays Creek, Prentiss Bay, Cut River, Epoufette. PRESQUE ISLE CO.–Evergreen Beach.

Although it belongs to a confusing complex, this species is surprisingly uniform in eastern North America where it can be recognized by keeled leaves with more or less thickened margins. Its crisped and secund leaves, when dry, and its occurrence on rotten logs are useful in identification.

8. **Dicranum spurium** Hedw.–Rather coarse plants in loosely cohering, dull, yellow-green or yellow-brown tufts (0.5)2-5(7.5) cm. high, moderately tomentose, usually interruptedly foliate. Leaves crowded, erect-spreading when moist, arched and loosely imbricate when dry and only slightly contorted, often ± undulate, 3-5 mm. long, 0.8-1.2 mm. wide, broadly acuminate from a broad, ovate base (narrowed toward the insertion), acute, serrulate in the upper 1/3 or more; costa 90-150 $\mu$ wide just above the alar region, percurrent or nearly so, ± ridged at back and slightly (or sometimes strongly) toothed above, often laterally spurred; upper cells 8-14 $\mu$ wide,

usually irregular in shape and arrangement, transversely elongate, subquadrate, or triangular, with unevenly thickened walls, strongly papillose at back (or very rarely nearly smooth), sometimes projecting at back as scattered teeth; lower cells elongate and porose; alar cells brownish, not extending to the costa. Male plants dwarfed. Setae 12-24 mm. long; capsules 1.75-2 mm. long, inclined to horizontal, curved and asymmetric, furrowed and ± strumose when dry; annulus of about 2 rows of large, pale cells, ± revoluble; operculum 1.7-2.5 mm. long. Spores 20-24 $\mu$.–n = 12, 24.

Conard, How to Know the Mosses, (ed. 2) fig. 58e-h. Grout, Mosses with Hand-lens and Microscope, fig. 45a, d, e, Moss Flora of North America 1: Pl. 46A.–**Fig. 241-243.**

On light, often sandy soil or on rock, apparently limited to dry, open places, such as scrubby oak, aspen, or pine woods, or rocky heaths or barrens. Circumpolar; Newfoundland to Michigan, south to Arkansas and North Carolina.

CHEBOYGAN CO.–Devereaux Lake. EMMET CO.–Wycamp Lake, Cecil Bay. PRESQUE ISLE CO.–Hammond Bay.

The shape of the leaves (broadly tapered from the base) and their arched-imbricate position when dry give a turgid appearance to the individual plants. The species approaches *D. sabuletorum* through intergrading forms.

9. **Dicranum sabuletorum** Ren. & Card.–Dull, yellow-brown plants in rather loose, tomentose tufts 1-3(5) cm. high, ± comose. Leaves erect-spreading when moist, curved or ± crisped when dry, indistinctly undulate, 3-6 mm. long, rather broadly lanceolate, broadly short-acuminate to slenderly long-acuminate, distinctly keeled, serrulate in the upper 1/3 or more; costa (75)90-140(160) $\mu$ wide near the base, shortly excurrent (or sometimes merely percurrent), often densely serrulate and papillose at back, sometimes nearly smooth, low-ridged; upper cells (9)11-15(17) $\mu$ wide, usually irregular in shape and size, mostly ± subquadrate with walls usually ± unequally thickened but arranged in well-marked longitudinal rows separated by fairly conspicuous pellucid lines, rather obscure, moderately papillose at back or nearly smooth, rarely projecting at back as scattered, very inconspicuous teeth at the undulations; lower cells narrow and elongate and slightly to strongly porose; alar cells brownish, not extending to the costa. Male plants dwarfed. Setae 13-22 mm. long; capsules 1.5-2 mm. long, curved, inclined to horizontal, ± strumose, somewhat furrowed when dry; annulus well developed, of 2 rows of cells, fragmenting; operculum 1.5-1.7 mm. long. Spores 21.23 $\mu$.–n = 12.

Conard, How to Know the Mosses, (ed. 2) fig. 59e-f, 120e-f. Grout, Mosses with Hand-lens and Microscope, fig. 45b, c, c′ (as *D. pallidum*). Welch, Mosses of Indiana, fig. 59 (as *D. condensatum*).–**Fig. 244-245.**

As the name indicates, on sand or other light soil, often on thin soil over rocks, rarely on humus, in dry, open coniferous forests. Endemic to North America; Nova Scotia to Michigan, south to Florida and Texas.

EMMET CO.–Wycamp Lake, Big Stone Bay. PRESQUE ISLE CO.–Huron Beach, Evergreen Beach, Clinton Lake.

Although closely related to *D. spurium*, *D. sabuletorum* is more likely to be confused with other, less nearly allied species. The leaves of *D. sabuletorum* vary from short, broad, and subacute, with a percurrent or shortly excurrent costa, to long, narrow, and slenderly acuminate, with a rather long-excurrent costa. The plants may resemble *D. drummondii*, but the single setae and less controrted leaves with a more regular arrangement of cells in longitudinal rows help to distinguish *D. sabuletorum*.

10. **Dicranum undulatum** Brid. (*D. bergeri* Bland.)–Rather robust plants in very compact, yellow-brown or green, moderately tomentose tufts 5-9(12) cm. high. Leaves erect-curved, not much altered on drying or somewhat contorted, often ± secund at stem tips, 5.5-9 mm. long, oblong-lanceolate, gradually narrowed to a broad acumen, broadly acute or obtuse, keeled (usually rather broadly so), undulate, serrulate in the upper ½ or more, erect at the margins (or occasionally ± revolute); costa 100-125 $\mu$ wide near the base, ending near the apex, rather indistinctly ridged, serrate at back above or sometimes nearly smooth; upper cells 11-16 $\mu$ wide, irregularly short-rectangular, in irregular longitudinal rows, ± pellucid, very incrassate, smooth or occasionally ± papillose at back, rarely a few cells projecting at back as scattered teeth. Male plants dwarfed. Setae single, 15-30 mm. long; capsules 2.5-4 mm. long, curved and asymmetric, inclined or horizontal, ± furrowed when dry, not strumose; annulus of 2(3) rows of larger, pale cells, fragmenting; operculum 2.5-3 mm. or more long. Spores 16-23 $\mu$.

Conard, How to Know the Mosses, (ed. 2) fig. 60d-e (as *D. bergeri*). Darlington, Mosses of Michigan, fig. 44 (as *D. bergeri*). Grout, Moss Flora of North America 1: Pl. 46B (as *D. bergeri*).–**Fig. 246-247.**

A characteristic species of peat bogs and boggy heaths, often growing in *Sphagnum* hummocks (most frequently under clumps of black spruce). Circumpolar.

CHEBOYGAN CO.–Gleasons Bog, Gates Bog, Maloneys Bog, Mud Lake, Little Lake 16. EMMET CO.–Conway Bog, Bear Creek Township, Stutsmanville, Galloway Bog, Cecil Bay, French Farm Lake. MACKINAC CO.–Hendricks, Little Dollar Lake, Peggley Lake. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Loon Lake, Clinton Lake.

Best recognized by its occurrence in peat bogs, *D. undulatum* usually grows in tall, compact tufts, with erect, broadly pointed, undulate leaves.

In typical form *D. undulatum* and *D. drummondii* are easily distinguished, but intergrades can be difficult. *D. drummondii* usually grows in dry coniferous woods in dull, loosely cohering tufts, whereas *D. undulatum* is characteristic of open bogs where it grows in compact, often rather shiny tufts in the shelter of black spruce and tamarack. The tomentum, abundant in both species, is more obvious in *D. drummondii* because the leaves are more distantly spaced and more contorted when dry. The leaves of *D. drummondii* are slenderly long-acuminate, narrowly acute, and sharply serrate in the upper half and especially near the apex. In *D. undulatum* the leaves are broadly acuminate and broadly acute or obtuse at the apex. The upper cells of *D. drummondii,* small (8-11 $\mu$), obscure, green, relatively thin-walled, subquadrate and arranged in regular longitudinal rows, are clearly papillose at back and often project as scattered dorsal teeth. In *D. undulatum,* the cells are larger (11-16 $\mu$), thick-walled, irregular in shape and arrangement, usually smooth, and only rarely projecting as teeth. Perhaps the most reliable character for distinguishing difficult specimens is the areolation of the leaf.

## 5. **Paraleucobryum** (Lindb.) Loeske

Plants rather robust, in gray-green or yellow, somewhat shiny tufts, scarcely to moderately radiculose below. Leaves erect-spreading to falcate-secund, lanceolate, gradually acuminate, subtubulose above; costa broad (less than 1/3 to about 9/10 the leaf base), filling most of the subula, without stereids but consisting of small, thick-walled green cells in a median layer and thick-walled, hyaline cells dorsally and ventrally (the green cells in *P. longifolium* also interspersed in rows among the hyaline

cells dorsally); cells of the lamina firm, smooth, hyaline, rectangular above, elongate below, the alar cells well differentiated. Dioicous; inner perichaetial leaves sheathing. Setae elongate, erect; capsules erect and symmetric, sometimes slightly curved, ± cylindric; operculum slenderly long-rostrate; peristome teeth 16, inserted below the mouth, red-brown, lanceolate, forked ½ way down or more, obliquely or ± vertically striolate. Spores spherical. Calyptra smooth, naked, entire at base.—The name refers to the costa which is similar in structure to that of *Leucobryum.*

**Paraleucobryum longifolium** (Hedw.) Loeske.—Plants green or yellowish, with a slight grayish sheen when dry, ± radiculose, 1-3.5 cm. high. Leaves usually falcate-secund, sometimes stiffly erect and fragile, 4-7.5 mm. long, lance-subulate, serrulate 1/2-2/3 down, roughened at back above; costa more than 1/2 the width of the base (sometimes as much as 2/3), filling all of the subula, consisting of 3-4 layers of thick-walled cells of nearly uniform size, the middle and dorsal layers with intermingled green cells (alternating rows of green and hyaline cells at back appearing as fine, longitudinal striations at low magnifications); inflated alar cells extending to the costa, hyaline to brownish; cells of lamina long-rectangular to linear, sometimes ± porose. Seta 9-20 mm. long, straw-colored; urn 1.5-3 mm. long, oblong-cylindric, straw-colored to brownish, tough-walled, usually irregularly furrowed when dry and empty; annulus none; operculum slightly shorter than the urn; peristome teeth obliquely or ± vertically striolate to the apex. Spores 23-37 $\mu$, densely and minutely roughened, obscurely green.—n = 12.

Conard, How to Know the Mosses, (ed. 2) fig. 122a-d. Grout, Mosses with Hand-lens and Microscope, Pl. 17 (as *Dicranum*), Moss Flora of North America 1: Pl. 44H (as *Dicranum*). Jennings, Mosses of Western Pennsylvania (ed. 1) Pl. 9 & (ed. 2) Pl. 13 (as *Dicranum*).—**Fig. 248-250.**

Most commonly on rocks in relatively moist woods (but also on bases of trees and rotten logs, or rarely humus or soil). Circumpolar; Alaska to Nova Scotia, south to Arizona, Colorado, Michigan, and North Carolina.

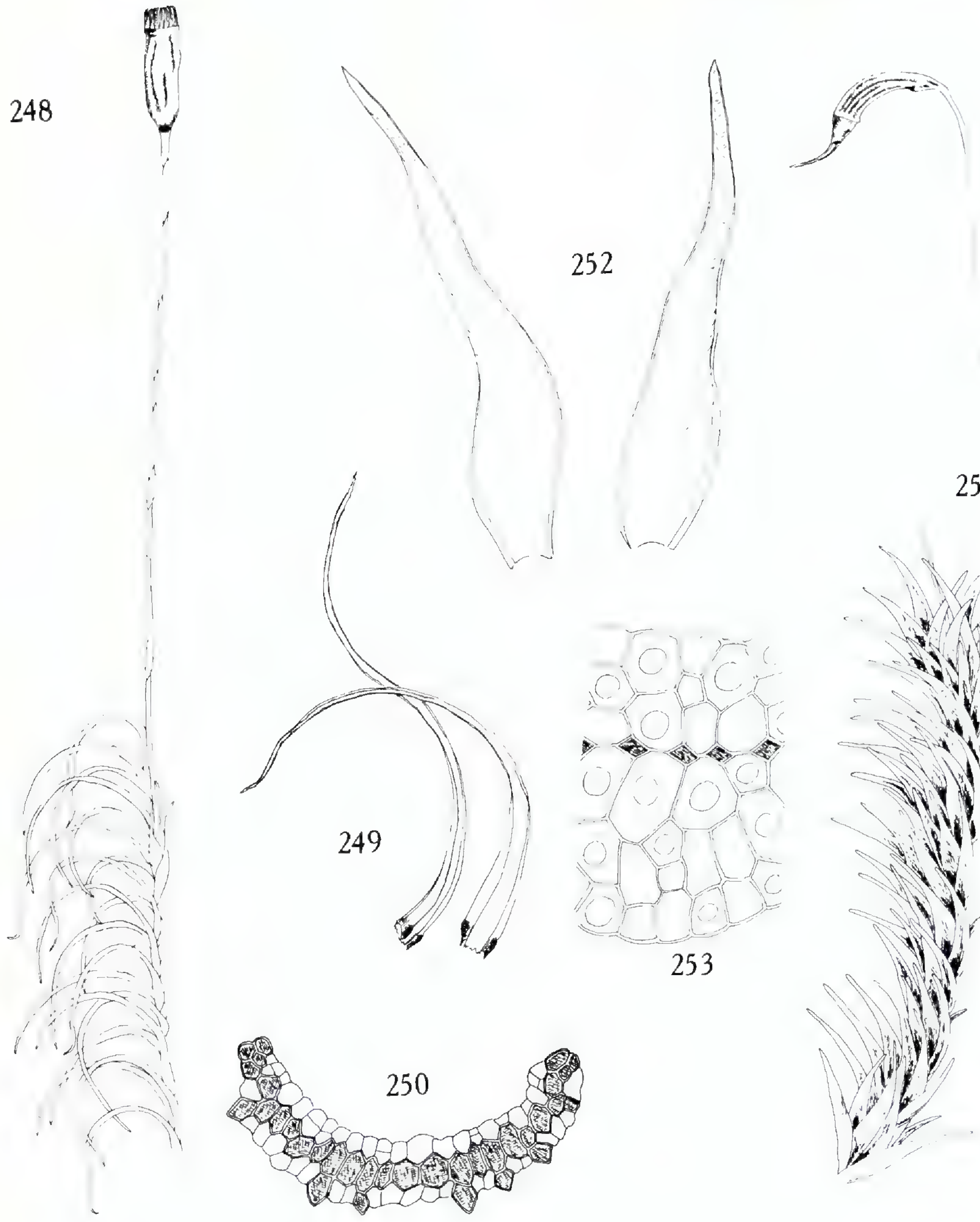
CHEBOYGAN CO.—Colonial Point. EMMET CO.—Middle Village, Cecil Bay. MACKINAC CO.—Mackinac Island, Bush Bay.

Resembling a *Dicranum* but recognized by a grayish sheen when dry and (with the aid of a lens) the apparent striolation of the leaves caused by longitudinal strips of green cells enclosed by hyaline cells. The leaves consist mainly of costa and in their curious structure indicate a transition to the Leucobryaceae.

Other members of the family found in the Upper Peninsula:

**Rhabdoweisia crispata** (With.) Lindb. occurs at the Upper Falls of the Tahquamenon River in Luce Co. The plants are very small. The leaves are narrow, acute, serrulate above, with smooth, subquadrate upper cells; the alar cells are scarcely differentiated. The inflorescence is autoicous. The capsules are erect and symmetric, obconic and 8-furrowed when dry and empty, and the peristome teeth are linear and smooth or faintly and irregularly striolate.

**Dichodontium pellucidum** (Hedw.) Schimp. occurs at the Lower Falls of the Tahquamenon in Chippewa County. The plants are rather small. The leaves are rather broad, oblong-lanceolate to lingulate, bluntly acute to rounded-obtuse, irregularly dentate, with upper cells subquadrate and mammillose or conic-papillose; the alar cells are not differentiated. The inflorescences are dioicous, the capsules suberect to curved and nodding, smooth, with well-developed peristome teeth which are vertically




*Paraleucobryum longifolium.* 248. Habit. 249. Leaves. 250. Cross-section of leaf.
*Leucobryum glaucum.* 251. Habit. 252. Leaves. 253. Cross-section at base of leaf.

pitted-striolate.—North American records of *Oreoweisia serrulata* (Funck) De Not. should be referred here.

*Cynodontium schisti* (Wahl.) Lindb., *C. strumiferum* (Hedw.) Lindb., *C. torquescens* Limpr. are small, autoicous mosses with lanceolate, acute, keeled leaves with margins bistratose and recurved and cells somewhat roughened by coarse, papillose bulges; the capsules are furrowed and the peristome teeth vertically pitted-striolate. **C. strumiferum** has capsules curved, inclined, and strumose at base; the peristome teeth are forked. **C. schisti** has erect, non-strumose capsules and undivided peristome teeth. **C. torquescens** has erect, non-strumose capsules and forked peristome teeth. All three occur in crevices of granitic rock.

**Dicranoweisia crispula** (Hedw.) Lindb. *ex* Milde grows on granitic rock ledges and crevices of cliffs, especially near streams, in the Upper Peninsula. The plants are small, dull, densely tufted, with leaves crisped and curled when dry; the cells appear papillose in section because of cuticular ridges running lengthwise; the perichaetial leaves are convolute-sheathing, the innermost ending abruptly in a broadly pointed or truncate apex; the capsules are erect and smooth; the peristome teeth are inserted below the mouth, undivided, and papillose throughout.

## LEUCOBRYACEAE

Rather coarse, whitish, grayish, or bluish-green or somewhat iridescent plants in dense, often large cushions or hummocks. Stems erect. Leaves thick and fleshy, linear, ligulate, or lanceolate from a somewhat broader base; costa filling the leaf point and most of the base, consisting of 2 or more layers of large, empty, hyaline, porose cells (leucocysts) enclosing a single ± median layer of small, green cells (chlorocysts); laminae very narrow, restricted to the base or sometimes extending above the shoulders as an inconspicuous border, consisting of delicate, hyaline, oblong to linear cells. Setae terminal, mostly elongate, erect; capsules erect and symmetric to inclined and asymmetric, often strumose at base; peristome single, consisting of 8-16 lanceolate, entire or bifid, smooth, papillose, or vertically pitted-striolate teeth.

### **Leucobryum** Brid.

Plants medium-sized to large, in dense, whitish, grayish or bluish-green cushions or hummocks. Stems forked. Leaves crowded, thick and fleshy, lanceolate or subulate-lanceolate and subtubulose from an oblong-obovate or elliptic base; the laminae very narrow, hyaline and delicate, essentially restricted to the base (extending somewhat to well above the shoulders as an inconspicuous border), the remainder of the leaf filled by the costa which consists of 2-8 layers of leucocysts enclosing a ± median layer of chlorocysts. Dioicous; male plants dwarfed, growing on or among the leaves of the female plants. Setae elongate, erect; capsules inclined, asymmetric, 8-ribbed, often strumose at base; annulus usually none; operculum long-rostrate; peristome teeth 16, lanceolate, bifid to the middle, vertically pitted-striolate below, papillose above. Spores spherical. Calyptra large, cucullate.—The generic name means white moss.

**Leucobryum glaucum** (Hedw.) Schimp.—Fairly robust plants in deep, hemispherical cushions usually 2-9 cm. high (but often much higher and forming very large hummocks), sometimes bearing clusters of reduced leaves at the stem tips. Leaves erect to erect-spreading or sometimes subsecund, 3-8 mm. long, lanceolate and concave or subtubulose from an erect, oblong-obovate base 1.5-3 mm. long, acute or apiculate, usually ± serrulate at the tip; costa in cross-section near the insertion showing 5-7 irregular layers of leucocysts on either side of the middle, with 3-4 layers below and 2-3 above the chlorocysts; lamina 5-11 cells wide. Setae 9-17 mm. long, red-brown; capsules 1.5-2 mm. long, curved and strongly inclined, strumose at base; annulus none; operculum 1.5-2 mm. long. Spores 13-18 $\mu$, nearly smooth or very finely papillose. Calyptrae often not split completely to the base which clasps the tip of the seta until maturity of the capsule.—n = ±11, 11, 14.

Breen, Mosses of Florida, Pl. 24 (figs. 1, 4). Conard, How to Know the Mosses, (ed. 2) fig. 29. Darlington, Mosses of Michigan, fig. 46. Grout, Moss Flora of North America 1: Pl. 52. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 10, (ed. 2) Pl. 14. Welch, Mosses of Indiana, fig. 62.—**Fig. 251-253.**

Common in moist forests on soil or humus (usually associated with very decomposed wood humus), occasional on rotten logs or stumps or bark at base of trees. Europe, Azores, Madeira, Canary Islands; Caucasus; Japan; Newfoundland to Minnesota, south to Florida and Louisiana.

CHEBOYGAN CO.–Douglas Lake, Reeses Bog, Gorge of Carp Creek, Iron Bridge, Colonial Point, Bryants Bog, Vincent Lake, Grass Bay. EMMET CO.–Arnott Lake, Galloway Bog, Carp Lake, Cross Village, Middle Village, Five Mile Creek, Cecil Bay. MACKINAC CO.–Bois Blanc Island, Hendricks. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Presque Isle Lighthouse, Clinton Lake.

Sometimes called WHITE MOSS or PIN CUSHION MOSS, *Leucobryum glaucum* is especially associated with wood humus, sometimes growing in large mounds representing logs or stumps in an advanced stage of decomposition. Occasionally one sees colonies up to several feet in diameter.

Sporophytes are rare, but small brood-leaves are sometimes produced in dense axillary clusters resembling loose cabbage heads, and the leaves often proliferate radicles at their tips and no doubt form new plants by regeneration following accidental breakage of the leaves. I would guess, however, that it is a dwarf male plant rooted on a leaf that Burrell (Bryol. 10: 107-111. Pl. 12, fig. 1. 1907) illustrated, rather than a small plant produced by regeneration, as he thought.

The localized dispersal of the species as a result of accidental disturbance is neatly illustrated by Störmer's observation that *Leucobryum* had spread along numerous paths that developed between 1935 and 1964 and in a wooded area made available for public camping (*Mosses with a Western and Southern Distribution in Norway,* p. 113. 1969).

Plants scratched loose by game birds or in some other accidental way may continue growth as rounded and unattached "moss balls." Burrell (Bryol. 10: 107-111. 1907) attributed such growths of *Leucobryum glaucum* to the scratching of pheasants. Other reports, of the same species, include papers by Gilbert (Bryol. 9: 72. 1906) and Dixon, as "Fawley Buns" (Bryol. 15: 31-32. 1912). Dixon, in the same article, reported similar growths of *Echinodium hispidum* in New Zealand resulting from the scratching of wood hens. In *The Student's Handbook of British Mosses,* he mentioned moss balls of *Porotrichum alopecurum.* Further information on this phenomenon in New Zealand was provided by Martin (Bryol. 55: 65-70. 1952). Shacklette reported a similar development of *Grimmia apocarpa* on Amchitka Island, Alaska, where plants become detached from their normal rock substrate by wind and assume a spherical growth form as a result of continual rolling on dune sands. These resemble "glacier mice" developed in a similar way on glaciers in Iceland and Alaska and moss balls on sand in Norway and Jan Mayen (Lid, Nytt Mag. Naturw. 78: 101-104. 1938). Heusser (Bull. Torrey Bot. Club 99: 34. 1972) reported, with a photograph, hundreds of rounded polsters of *Drepanocladus berggrenii* (C. Jens.) Roth on glacial ice in Alaska.

Moss balls call to mind other vagabonds, such as the tumbleweeds of the American prairies or the manna which fell from Heaven as food for the Children of Israel. Manna is believed to have been, in part, a lichen, *Lecanora esculenta,* which occurs in arid wastes of North Africa and the Near East. It becomes detached and blown great distances by the wind. Sometimes eaten by men and his animals, it has food value, although it is abrasive to the teeth!

**Leucobryum albidum** (Brid.) Lindb., found once in Washtenaw County in the extreme southern part of the state, and common farther south, is much smaller with leaves only 2-4 mm. long; the leaf point is about the same length as the base and the costa consists of 2 (or rarely here and there, 3) hyaline cells above and below the green cells on either side of the median region at leaf base.

## ENCALYPTACEAE

Plants rather small to moderately robust, loosely to densely tufted. Stems erect, forked. Leaves elliptic to oblong-ovate or oblong-obovate, rounded-obtuse to acuminate, sometimes apiculate or awned, ± concave or keeled; margins evenly papillose-crenulate or crenate-serrulate above, entire and sometimes revolute below; costa single, strong, ending below the apex to shortly excurrent or ending in the awn, prominent and often papillose or ± toothed at back, consisting of a dorsal stereid band and large ventral cells; upper cells hexagonal, firm-walled, bulging, and densely forked-papillose on both surfaces and obscure (or, in *Bryobrittonia,* mammillose and pellucid); basal cells pale, lax, oblong (with thickened, brown cross-walls in *Encalypta*), the basal marginal cells smooth, pale, and linear in several rows. Setae terminal, elongate, erect or somewhat flexuose, usually twisted above when dry; capsules erect and symmetric, cylindric, with a short and usually inconspicuous neck, smooth or furrowed; annulus present; operculum erect, long-rostrate; peristome lacking, single, or double, the 16 teeth lanceolate to linear or filiform, the endostome segments rising from a low membrane, pale and delicate, often ± adherent to the teeth. Calyptra mitrate, large, conic-cylindric and long-rostrate, fringed at base.

### **Encalypta** Hedw.

Rather small to fairly robust plants in dense tufts, dull-green or brownish-green and often glaucous above, brown and radiculose below. Leaves elliptic or ovate to oblong-obovate, rounded-obtuse to acute or acuminate, often apiculate or hyaline-awned, usually concave or somewhat keeled, often folded and contorted when dry; costa ending well below the apex to percurrent or ± excurrent, sometimes disappearing in the awn; upper cells green and obscure, densely forked-papillose on both surfaces; basal cells large, lax, smooth, oblong, with brown, thickened cross-walls, the basal marginal cells pale and linear in several rows. Setae usually twisted above when dry, erect or flexuose; capsules smooth or furrowed; peristome lacking, single, or double, the teeth 16, lanceolate to filiform, entire or variously divided, papillose, the segments pale and delicate, papillose, usually ± adherent to the teeth, rising from a low membrane adherent to the teeth.—The name means covered with a veil, in reference to the large calyptra resembling a candle-snuffer, hence the common name of EXTINGUISHER MOSS. The lax basal cells with thickened and colored cross-walls are useful in recognition of the genus from sterile material. Other interesting features of the genus include the variability of the peristome, single, double, or lacking, from one species to another and the very distinctive and recognizable spores of the various species.

1. Plants relatively robust, usually sterile and commonly bearing abundant, brown, filiform brood bodies on stems; uppermost and perichaetial leaves of fruiting plants piliferous, the others muticous; capsules spirally furrowed; peristome double; spores 16-26 $\mu$, very finely papillose ..... 3. *E. procera*

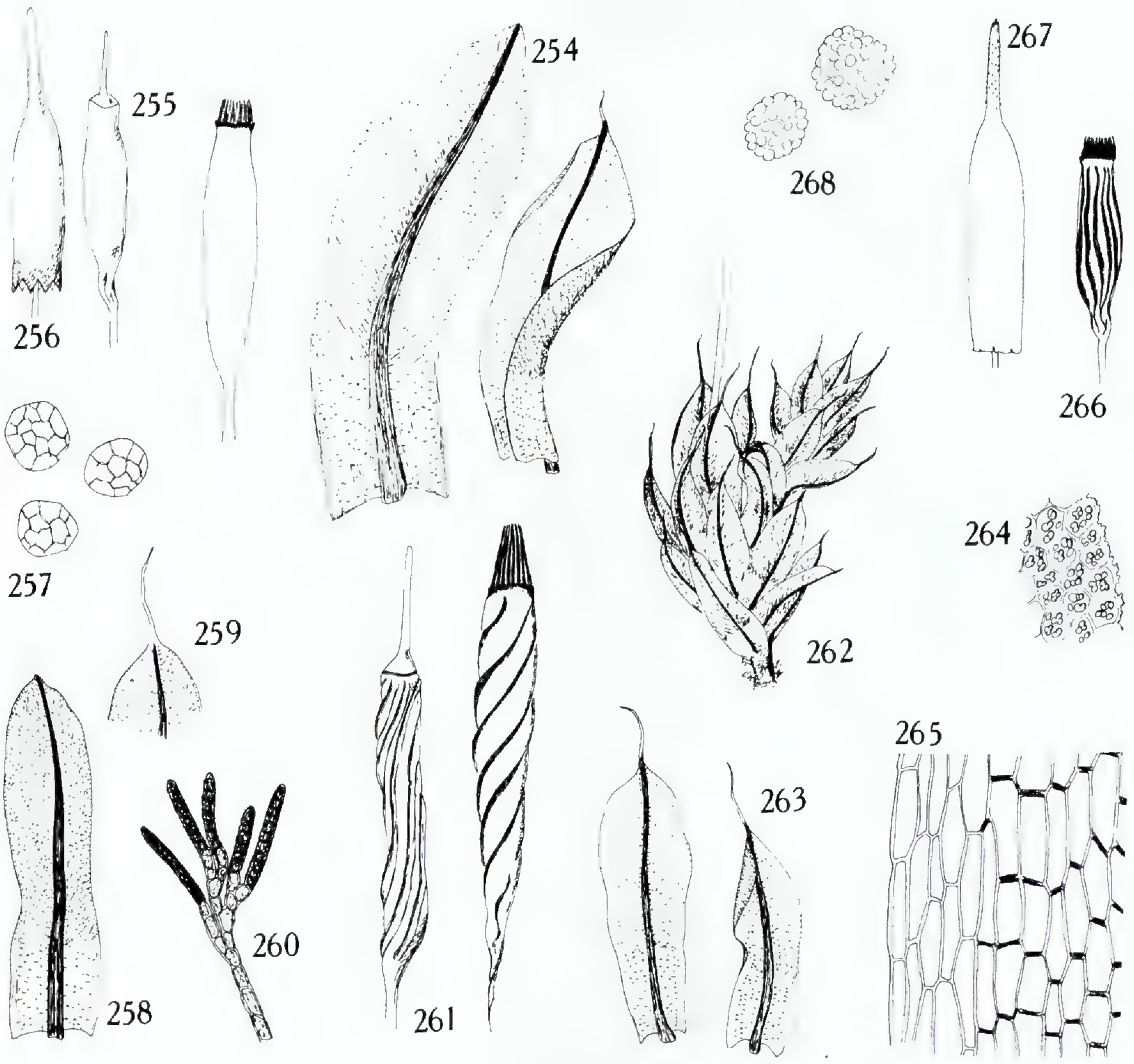
1. Plants smaller, usually fruiting, without brood bodies; leaves apiculate or awned; capsules not spirally furrowed; peristome single; spores 27 $\mu$ or more, not finely papillose
   2. Leaves acute and hyaline-awned; capsules strongly straight-ribbed; spores (27)35-45 $\mu$, warty; calyptra slightly erose at base ..... 2. *E. rhaptocarpa*
   2. Leaves rounded-obtuse to broadly acute, abruptly narrowed to a yellow apiculus; capsules smooth; spores 28-36 $\mu$, wrinkled-reticulate; calyptra deeply fringed at base ..... 1. *E. ciliata*

1. **Encalypta ciliata** Hedw.—Plants 5-40 mm. high, dull-green or yellow-brown above, brown below. Leaves ± folded and contorted when dry, 2.5-4 mm. long, elliptic to oblong-obovate, rounded-obtuse to broadly acute, ending abruptly in a smooth,

yellow apiculus; margins plane or erect above, or ± incurved at the apex, revolute below the middle; costa ending near the apex to shortly excurrent, smooth at back or sometimes slightly toothed near the apex; upper cells 11-18 $\mu$. Autoicous. Setae 4-10 mm. long, yellow or brown; capsules 2-3 mm. long, light- to dark-brown, smooth (but usually very finely wrinkled-striolate when old), thin-walled and often becoming torn or shredded wtih age; annulus poorly developed, of 1 row of cells; operculum 1-1.6 mm. long; peristome single, the teeth lanceolate, finely papillose and often ± striolate as well, brown or rarely reddish-brown. Spores spherical, 28-36 $\mu$, smooth (or very rarely faintly roughened) but irregularly wrinkled-reticulate within. Calyptra smooth, fringed at base.—n = 13.

Conard, How to Know the Mosses, (ed. 2) fig. 77. Darlington, Mosses of Michigan, fig. 47. Grout, Mosses with Hand-lens and Microscope, Pl. 37, Moss Flora of North America, 1: Pl. 71B.—**Fig. 254-257.**

On ledges or in crevices of limey cliffs, also on soil of banks, especially in the shelter of overhanging sod. Europe, Africa, and Asia; Alaska to Labrador, south to California, Arizona, New Mexico, Iowa, and Pennsylvania; Mexico and Ecuador.




*Encalypta ciliata.* 254. Leaves. 255. Capsules. 256. Calyptra. 257. Spores.

*Ecalypta procera.* 258. Leaf. 259. Apex of perichaetial leaf. 260. Brood-bodies. 261. Capsules.

*Encalypta rhaptocarpa.* 262. Habit. 263. Leaves. 264. Upper cells of leaf. 265. Basal cells of leaf. 266. Capsule. 267. Calyptra. 268. Spores.

CHEBOYGAN CO.–Fairy Island (Douglas Lake), also "Cheboygan." EMMET CO.–Cross Village.

Recognized by smooth capsules with a single, red-brown peristome. The spores, smooth on the outside but irregularly wrinkled-reticulate within, are oddly distinctive.

2. **Encalypta rhaptocarpa** Schwaegr.–Plants 5-30 mm. high, dull-green to yellowish or brownish above, brown below. Leaves somewhat keeled and incurved but usually not much contorted when dry, 2.2-3 mm. long, ovate, broadly acuminate, acute and hyaline-awned; margins plane, or erect near the apex; costa ending below the apex to percurrent or disappearing in the awn, smooth or somewhat papillose at back, especially below; upper cells 11-16 $\mu$. Autoicous. Setae 6-10 mm. long, brown or red-brown; capsules 2-3 mm. long, dark- or red-brown, abruptly narrowed at the base, strongly straight-ribbed, wrinkled at the short neck when dry; annulus of 2 rows of small, usually persistent cells; operculum 1.1-2 mm. long; peristome single, the teeth lanceolate, brown or reddish, rather coarsely papillose (sometimes with pre-peristome fragments adhering to their bases). Spores (27)31-45 $\mu$, spherical or subreniform, coarsely warty-papillose, the papillae about 5-8 $\mu$ in diameter. Calyptra smooth or ± scabrous above, slightly erose at base.–n = 26.

Conard, How to Know the Mosses, (ed. 2) fig. 76e-f. Grout, Moss Flora of North America 1: Pl. 69B.–**Fig. 262-268.**

On soil, often in crevices of dry, calcareous cliffs or in the shelter of turf overhanging steep banks. Circumpolar; Greenland to Alaska and south to New York, Michigan, South Dakota, New Mexico, Arizona, and California.

CHEBOYGAN CO.–Fairy Island (Douglas Lake). EMMET CO.–Cross Village. MACKINAC CO.–Mackinac Island, Bush Bay.

Distinctive features include the capsules with straight ribs, a single peristome, and large, warty spores. In most books the specific epithet is spelled *rhabdocarpa,* but the original spelling in Schwaegrichen's herbarium and in his publication was *rhaptocarpa.* A western species, **E. vulgaris** Hedw., collected in Ontario by Macoun (if label information can be trusted), differs mainly in the absence of a peristome.

3. **Encalypta procera** Bruch–Plants 15-20 mm. high, dull-green or brownish-green above, brown below, often bearing abundant, brown, filiform brood-bodies on simple or branched radicles on the stems. Leaves ± folded and contorted when dry, 2-4 mm. long, oblong-ovate or oblong-elliptic, obtuse or broadly acute (or occasionally rounded-obtuse), the upper and perichaetial leaves hyaline-awned; margins plane or erect above, often reflexed or revolute in the lower 1/2-2/3; costa ending well below the apex to percurrent or disappearing at the base of the awn, roughly papillose at back toward the base and often papillose nearly or quite to the apex; upper cells 10-16 $\mu$. Autoicous. Setae 11-17 mm. long, red-brown; capsules 2.5-3 mm. long, spirally ribbed; annulus revoluble in fragments; operculum 1.5-1.8 mm. long; peristome double, the teeth long-filiform, red, finely papillose, perforate near the base and joined together by trabeculae, the segments linear, about 2/3 as long as the teeth and ± adherent to them below, yellow or orange-brown. Spores spherical, 16-26 $\mu$, very finely papillose. Calyptra densely papillose above and occasionally ± papillose nearly to the base, lacerate-fringed. (Usually sterile and bearing abundant brood-bodies in eastern North America.)–n = 26+1, 27.

Grout, Moss Flora of North America 1: Pl. 72 (figs. 1-14). Jennings, Mosses of Pennsylvania, (ed. 2) Pl. 62 (as *E. streptocarpa*).–**Fig. 258-261.**

A calciphile, growing on or in crevices of damp rocks and cliffs, also on soil of cliff ledges and road banks. Circumpolar; Greenland to Alaska, south to Idaho, Missouri, Ohio, and North Carolina.

CHEBOYGAN CO.–Biological Station campus. EMMET CO.–Levering, Good Hart, Cross Village, Cecil Bay, Big Stone Bay. MACKINAC CO.–Caffey Corner, Mackinac Island, Castle Rock, McKays Creek, Bush Bay, Ozark, Rexton. PRESQUE ISLE CO.–Ocqueoc Falls.

The essentials of this species include the autoicous inflorescence, long, spirally ribbed capsules, and long, double peristome (with the endostome adhering to the exostome and, therefore, easily overlooked). Sporophytes are rare in eastern North America but common in the West. Our eastern plants become rather large because of continued vegetative growth and are best recognized by masses of brown, filiform brood-bodies borne on simple or branched radicles on the stems, often crowding the leaves and causing them to be incurved-contorted when dry. All records of *E. streptocarpa* Hedw. from North America are based on such sterile forms, which do, however, fruit on occasion and are indeed autoicous, proving them to be *E. procera.* There is no positive evidence (such as a supposed central strand) for calling them *E. streptocarpa,* and whenever fruiting plants have been found there has been no question of their identity with *E. procera.*

The leaves of the sterile form are muticous. The perichaetial leaves and upper leaves of fruiting plants are hyaline-awned.

## POTTIACEAE

Small to robust plants, usually in dense, dull, sometimes radiculose tufts. Stems erect, simple or forked. Leaves in several rows, mostly narrowly lanceolate, usually contorted when dry; costa single, well developed, mostly with 1 or 2 stereid bands; upper cells generally small and obscure, subquadrate or hexagonal, firm- or thick-walled, and mostly papillose; lower cells mostly pale and oblong, not differentiated at the basal angles. Sporophytes mostly terminal; setae usually elongate, erect; capsules mostly erect and symmetric, usually subcylindric, smooth; annulus sometimes differentiated; operculum generally differentiated and usually conic-rostrate; peristome usually present, single, the 16 teeth erect, oblique, or spirally wound together, entire or deeply divided to a low or high basal membrane into 32 filiform, papillose divisions. Spores usually spherical. Calyptrae cucullate.

Our genera fall into two large and heterogeneous subfamilies: The TRICHOSTOMOIDEAE (*Gymnostomum, Weissia, Tortella, Bryoerythrophyllum, Didymodon,* and *Barbula*) generally have a costa with two stereid bands of thick-walled cells separated by a median row of large empty guide cells and leaf cells with papillae usually blunt and simple (or none). The POTTIOIDEAE (*Phascum, Pottia, Desmatodon,* and *Tortula*) generally have only a dorsal stereid band, and the leaf cells most often have C-shaped papillae. (The Germans aptly refer to them as hufeisenförmig, or horse-shoe shaped.)

1. Basal cells of leaves large, lax, and hyaline, extending up the margins above the shoulders as a V-shaped border ..... 3. *Tortella*
1. Basal cells various, not extending upward as a V-shaped border
  2. Leaf margins involute ..... 2. *Weissia*
  2. Leaf margins plane or recurved
    3. Capsules immersed, without an operculum, dehiscing irregularly ..... 7. *Phascum*
    3. Capsules exserted, dehiscing by means of an operculum

4. Leaf margins plane or narrowly recurved on 1 side below the middle; peristome none (or rarely very rudimentary and difficult to demonstrate)
5. Plants caespitose on wet, calcareous rocks; leaves with essentially parallel sides, blunt or acute to apiculate, not awned; costa with 2 stereid bands; peristome none 1. *Gymnostomum*
5. Plants scattered or gregarious, on disturbed soil; leaves without parallel sides, oblong-lanceolate, oblong-ovate, or obovate, ending in a stout apiculus or awn; margins usually plane (rarely somewhat recurved on both sides at the middle); costa with 1 stereid band; peristome none (or rarely very rudimentary) 8. *Pottia, p.p.*

4. Leaf margins recurved on both sides; peristome mostly present and well developed
6. Basal cells subquadrate to oblong, not much enlarged, ± firm-walled
7. Plants scattered or gregarious; leaves ending in a stout apiculus or short awn; costa with 1 stereid band; peristome none (or rarely very rudimentary) 8. *Pottia, p.p.*
7. Plants tufted; leaves muticous or moderately apiculate; peristome present and well developed
8. Peristome teeth split nearly to the base into 32 filiform divisions and spirally wound together 6. *Barbula*
8. Peristome teeth deeply but often irregularly bifid into filiform divisions, erect or somewhat inclined, not spirally wound together 5. *Didymodon*

6. Basal cells ± enlarged, lax, pale, thin-walled
9. Leaves lanceolate, with a few irregular, pellucid teeth near the apex; costa with 2 stereid bands 4. *Bryoerythrophyllum*
9. Leaves broader, oblong-lanceolate to oblong-ovate or elliptic, not toothed; costa with 1 stereid band
10. Leaves acute or subulate to hair-pointed; basal leaf cells enlarged, usually in rather abruptly differentiated groups; peristome consisting of 32 filiform divisions spirally wound together above a high, tesselated basal membrane 10. *Tortula*
10. Leaves rounded-obtuse and sometimes apiculate; basal cells not abruptly differentiated; peristome teeth split to a low basal membrane into 2 (or 3) slender divisions, somewhat spiraled but not wound together 9. *Desmatodon*

## 1. **Gymnostomum** Nees, Hornsch. & Sturm

Plants small to fairly robust, growing on wet, usually calcareous rocks in dense, dull, green, glaucous, or yellowish tufts, rusty-brown below. Stems erect, forked. Leaves ± curved or incurved-contorted when dry, erect-spreading or rarely recurved when moist, linear-lanceolate to broadly ligulate, acute and sometimes apiculate or bluntly pointed to obtuse, concave or somewhat keeled; margins entire, plane or recurved on 1 side below; costa ending near the apex, homogeneous in structure or sometimes with 1 or 2 stereid bands; upper cells rounded or rounded-hexagonal, firm-walled, pluri-papillose on both surfaces and obscure (or rarely nearly smooth and pellucid); lower cells short-rectangular to irregularly oblong, smooth, pale, firm- or thick-walled. Dioicous; perichaetial leaves scarcely differentiated. Setae terminal, elongate, erect or somewhat flexuose; capsules erect and symmetric, ovoid, oblong-cylindric, or obovoid, smooth; operculum obliquely long-rostrate, sometimes remaining attached to the columella after dehiscence; annulus and peristome none. Calyptra smooth, naked.—The name means naked mouth, referring to the absence of a peristome.

Leaves acute and typically ending in a sharp, smooth, usually pellucid cell; margins recurved on 1 side below; capsules dull, dark-brown, obovoid, systylious 2. *G. recurvirostrum*
Leaves acute or bluntly pointed, not ending in a smooth, pellucid cell; margins plane; capsules ovoid or oblong-cylindric, glossy, the operculum readily deciduous 1. *G. aeruginosum*

1. **Gymnostomum aeruginosum** Sm.—Small plants in dirty-green tufts usually 2-7 mm. high (or rarely 40 mm.). Leaves loosely erect-incurved and moderately crisped when dry, spreading when moist, often with recurved tips, about 1-1.3 mm. long, ligulate or linear-lanceolate, bluntly acute to narrowly rounded-obtuse (with an occasional leaf ending in a sharp, pellucid cell), concave but not particularly keeled;

margins plane, often sinuate, papillose-crenulate; costa disappearing near the apex, with 2 stereid bands and a median row of guide cells; upper cells 7-11 $\mu$, rounded-hexagonal, obscure and pluripapillose; lower cells short-rectangular, moderately firm-walled. Setae 3-5 mm. long, yellow; capsules 0.6-0.8 mm. long, oblong-cylindric, shiny, pale-brown, thin-walled, finely shriveled-striolate when dry and empty; operculum 0.5-0.7 mm. long, readily deciduous. Spores 10-13 $\mu$, very slightly roughened.—n = 13.

Breen, Mosses of Florida, Pl. 36 (figs. 5-8), as *G. calcareum*. Darlington, Mosses of Michigan, fig. 50. Grout, Mosses with Hand-lens and Microscope, Pl. 25 (as *G. rupestre*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 12 & (ed. 2) Pl. 16 (as *G. calcareum*).—**Fig. 269-271.**

On moist or wet, shaded, generally calcareous cliffs or boulders, rarely on soil. Circumpolar; southeastern Alaska and British Columbia to Newfoundland, south to Arizona, Colorado, Arkansas, and North Carolina; Mexico and Guatemala.

CHEBOYGAN CO.—Mill Creek. MACKINAC CO.—Mackinac Island, Ozark.

The plants are quite small, and a confusion with the still smaller Seligerias is possible, Sporophytes are common and aid in distinguishing from the following species which has broader, systylious capsules. Sterile material is distinguished by the plane leaf margins and blunter leaf tips of *G. aeruginosum.*

Because outcropping limestone is rare on the south side of the Straits, *Gymnostomum aeruginosum* figures as a rarity at Mill Creek, in company with other calciphiles of local interest, including *Seligeria campylopoda* and *Platydictya confervoides.* Nichols (Trans. Conn. Acad. Arts & Sci. 22: 249-467. 1918) reported a pronounced calciphilous element on gypsum outcrops in Nova Scotia, featuring such mosses as *Distichium inclinatum, Gymnostomum aeruginosum, Encalypta procera, Myurella sibirica, Thuidium abietinum,* and *Tortula mucronifolia.* This is a typically calcicolous assemblage similar to that found on the minuscule cliffs at Mill Creek and in Mackinac and Presque Isle Counties.

**Gyroweisia tenuis** (Hedw.) Schimp., a rare moss found on soft, red Cambrian sandstone in Houghton County in the Upper Peninsula, is much like *G. aeruginosum* but has longer, more cylindric capsules, well-developed annulus, differentiated perichaetium, and blunt, rounded leaf apex with the costa ending well below it. The differences are well illustrated by Steere (Bryol. 42: 16-23. 1939), although he erred in using the name *Gymnostomum calcareum* Nees, Hornsch. & Sturm for the Michigan material of *G. aeruginosum* which he actually illustrated. (*Gymnostomum calcareum* is a Mediterranean species which has been found in California but not the eastern United States.)

2. **Gymnostomum recurvirostrum** Hedw.—Plants small to moderately robust, 5-30 mm. high (or rarely 50 mm. or more), in dark-green or yellow-brown tufts, brownish below and often somewhat radiculose, usually encrusted with lime. Stems frequently interruptedly foliate, sometimes ± papillose. Leaves loosely erect and somewhat contorted or occasionally appressed in 5 spiral rows when dry, erect-spreading, often with ± recurved tips when moist, 0.8-2 mm. long, linear-lanceolate to oblong-lanceolate, acute (or rarely some leaves blunt), usually ending in a sharp, smooth, pellucid cell, keeled; margins papillose-crenulate above and occasionally papillose-serrate somewhat above the base, recurved on 1 or very rarely both sides below; costa vanishing near the apex, with a small dorsal stereid band; upper cells 8-11 $\mu$, irregularly hexagonal, subquadrate, or short-rectangular, obscure and densely papillose to nearly smooth and pellucid; lower cells ± enlarged, irregularly oblong, thick-walled and often porose. Setae 5-11 mm. long, yellowish, becoming red-brown

with age; capsules 1-1.5 mm. long, obovoid or sometimes subcylindric, usually dark-brown, dull, firm-walled, smooth; operculum 1-1.2 mm. long, remaining attached to the columella for some time after dehiscence. Spores 16-20 $\mu$, very finely roughened.–n = 12+1, 13.

Conard, How to Know the Mosses, (ed. 2) fig. 97a-c. Darlington, Mosses of Michigan, fig. 52 (as *Hymenostylium*). Grout, Mosses with Hand-lens and Microscope, Pl. 24 (as *G. curvirostre*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 12 (as *Hymenostylium curvirostre*), (ed. 2) Pl. 16 (as *H. recurvirostrum*). Welch, Mosses of Indiana, fig. 69.–**Fig. 272-273.**

On wet, calcareous cliffs (and locally on low ridges of dune sand around moist depressions along the south shore of the Straits). Europe, Asia, Philippine Islands; New Guinea; Mexico, Guatemala, West Indies; Alaska to Greenland and south to Texas and Arizona, widespread in the East, south to Tennessee and Arkansas.

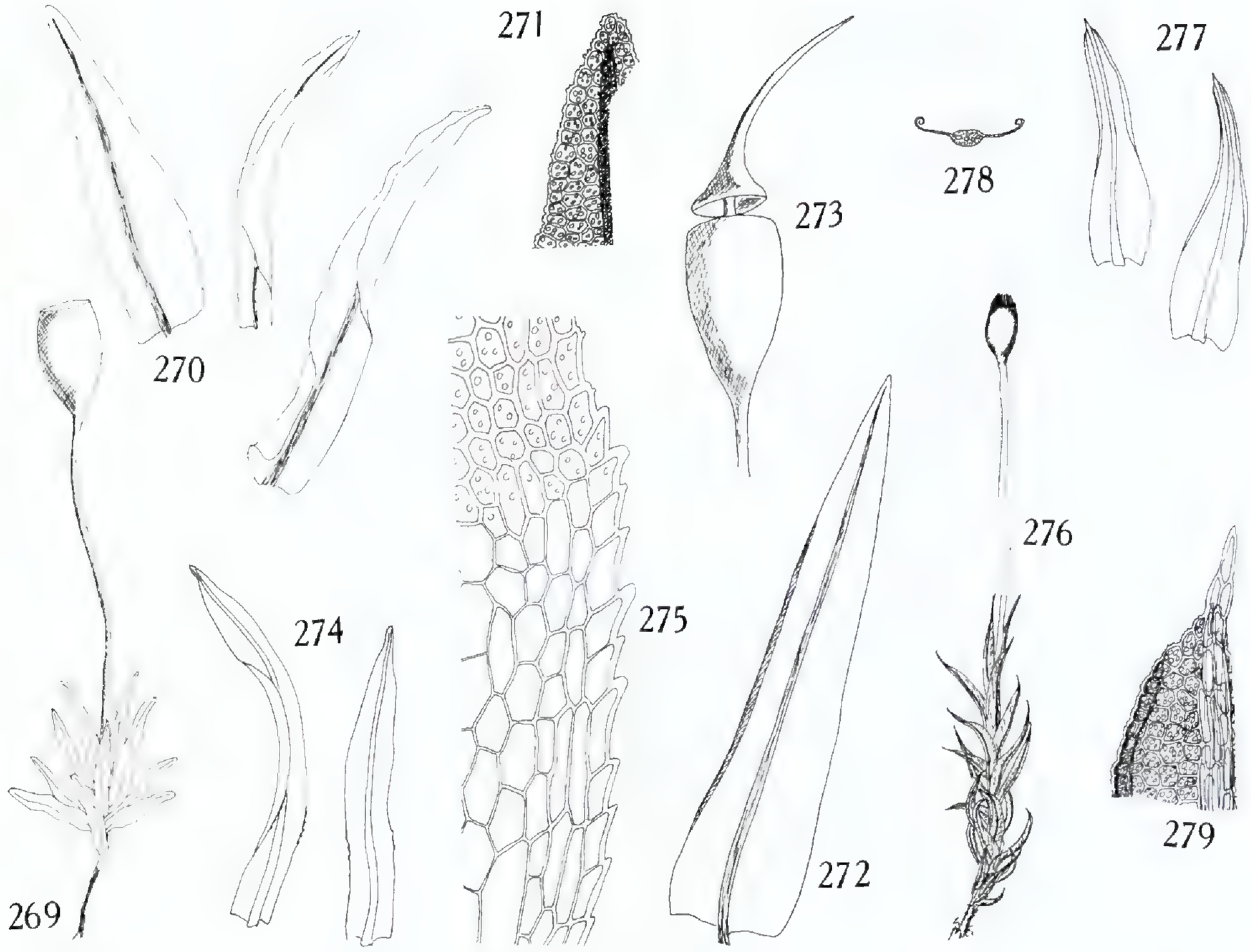
EMMET CO.–Cecil Bay.

The leaf margins narrowly recurved on one side offer a convenience in determination. The systylious capsules, though curious and very different in appearance from those of *G. aeruginosum*, scarcely justify the segregation of the genus *Hymenostylium*. I expect a good deal of variation in plants growing in aquatic or subaquatic habitats and particularly those found in limey places where alkalinity and pH vary with seasonal fluctuations in the water supply. For this reason, I am not much impressed with forms with papillose stems, referable to var. **latifolium** (Zett.) Flow. *ex* Crum [var. *scabrum* (Lindb.) Grout], or those with cells less papillose than usual, or nearly smooth, and therefore pellucid, called the var. **commutatum** (Mitt.) Grout. Neither of these so-called varieties has yet been found in the Straits area. The single local collection of the species, from wet, calcareous sands, certainly came from an anomalous habitat. The species is almost certain to be found in Mackinac County or Presque Isle County where wet, outcropping limestone rocks are occasional.

**Eucladium verticillatum** (Brid.) BSG (fig. 274-275) has been found on Summer Island in Lake Michigan (Delta Co.). It is a tufa-forming species similar to *Gymnostomum recurvirostrum* in both habitat and appearance, but recognized by plane leaf margins which are irregularly serrate near the junction of the green, upper cells and the pale, enlarged basal cells. The chromosome number reported for *E. verticillatum* is n = 13.

## 2. **Weissia** Hedw.

Small plants in dull, green, yellowish or brownish, loose or dense tufts. Leaves becoming somewhat larger toward the stem tips, strongly curled and contorted when dry, erect-spreading or spreading when moist, narrowly lanceolate or linear-lanceolate from a rather narrow, oblong base, acute and apiculate, ± subtubulose above, especially when dry; margins incurved or inrolled, usually from the shoulders to the apex; costa shortly excurrent as a smooth, pellucid apiculus, with 2 stereid bands; upper cells small, hexagonal, firm-walled, densely papillose on both surfaces and obscure; lower cells short-rectangular, smooth, pale. Perichaetial leaves not much differentiated. Setae terminal, mostly elongate, straight; capsules erect and symmetric, ellipsoidal to oblong-cylindric, annulus none or narrow and persistent; operculum rostrate; stomata at extreme base of the capsule; peristome lacking (sometimes with the mouth ± closed by an evanescent membrane) or consisting of 16 short (and sometimes rudimentary), entire or somewhat cleft and perforate, erect, papillose teeth. Calyptrae smooth, naked.–Named by Hedwig for Friederich Wilhelm Weiss, a cryptogamic botanist of




*Gymnostomum aeruginosum.* 269. Habit. 270. Leaves. 271. Cells at leaf tip.
*Gymnostomum recurvirostrum.* 272. Leaf. 273. Capsule.
*Eucladium verticillatum.* 274. Leaves. 275. Cells at margin of leaf shoulder.
*Weissia controversa.* 276. Habit. 277. Leaves. 278. Cross-section of upper portion of leaf (diagrammatic). 279. Cells at leaf tip.

Göttingen. (The name in older books was often spelled Weis and the genus *Weisia.* I prefer to adapt the generic name to the usual spelling of the surname. Anyway, the spelling used by Hedwig in the *Species Muscorum,* 1801, was *Weissia.*)

**Weissia controversa** Hedw.—Plants about 2-5 (or very rarely 10) mm. high. Leaves 1-2.5, sometimes 3 mm. long, linear-lanceolate from an oblong base; costa 45-60 $\mu$ wide near the base; upper cells 6-8 $\mu$. Autoicous (but often appearing to be dioicous). Setae 3-15 mm. long (but usually only 4-8 mm.), yellow; capsules 0.7-1.5 mm. long, oblong-cylindric, ± plicate when dry and empty, yellow-brown, becoming chestnut-brown with age; annulus poorly differentiated; operculum obliquely long-rostrate, 0.5-0.8 mm. long; peristome teeth short, lanceolate, sometimes slightly and irregularly cleft or perforate, red-brown. Spores 15-20 $\mu$, finely papillose, brown.—n = 13, 14.

Breen, Mosses of Florida, Pl. 38 (figs. 1-5). Conard, How to Know the Mosses, (ed. 2) fig. 84 (as *W. viridula*). Darlington, Mosses of Michigan, fig. 49. Grout, Mosses with Hand-lens and Microscope, Pl. 23 (as *W. viridula*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 12 & (ed. 2) Pl. 16 (as *W. viridula*). Welch, Mosses of Indiana, fig. 67 (as *W. viridula*).—**Fig. 276-279.**

On bare, calcareous soil in exposed and disturbed habitats, such as old fields and roadsides. Widely distributed in Europe, Asia, Africa, New Zealand; Mexico, Central and South America, West Indies; British Columbia to Nova Scotia and throughout the United States.

CHEBOYGAN CO.—Biological Station campus, Mill Creek. EMMET CO.—Brutus, Pellston Hills, Galloway Lake, Sturgeon Bay Point. MACKINAC CO.—Allenville. PRESQUE ISLE CO.—Posen.

Recognized by its small size and crisped leaves with involute upper margins, this species seems rare locally, perhaps because like most denizens of old fields it escapes competition by completing its life cycle quickly in spring or fall, when bryological activity is locally at a minimum. Similarly, at some off-season, one might find *Astomum,* which is a *Weissia* with immersed, cleistocarpous sporophytes. **Astomum muhlenbergianum** (Sw.) Grout has been found in Michigan.

Claire Williams (Bryol. 69: 361-365. 1966) found large numbers of sporophytes that were hybrids between *Astomum muhlenbergianum* and *Weissia controversa,* in Ontario. All the hybrids were produced on *Astomum* gametophytes and in the presence of both parent species. Similarly, Reese and Lemmon (Bryol. 68: 277-283. 1965) reported hybridization between *Weissia controversa* and *Astomum ludovicianum,* in Louisiana. The poorly formed spores produced by some of the intermediates gave supporting evidence of hybrid origin. Because of such hybridization Reese and Lemmon transferred all the North American species of *Astomum* to *Weissia.* Crundwell & Nyholm (Jour. Bryol. 7(1): 7-19. 1972) cited several other generic crosses linking *Astomum, Hymenostomum,* and even *Tortella.* I feel that here, as in the Funariaceae, intergeneric crosses may occur occasionally and under unusual circumstances, but in practice there is almost never any difficulty in recognizing them as distinct genera. After all, closely related genera are branches of a phylogenetic tree rather than separate creations. It is convenient and right to retain such recognizable branches (or evolutionary trends) as *Funaria* and *Entosthodon,* for example, as genera. One should expect occasional cases of cytological compatibility. In nature, spatial, temporal, and ecological barriers make hybridization unlikely.

Khanna (Bryol. 63: 1-16. 1960) made an interesting study of variability in *Weissia exserta* (Broth.) Chen, which may also be regarded as *Hymenostomum exsertum* (Broth.) Broth., in the Punjab and concluded that it is a young and vigorous species which originated as a result of hybridization between *Astomum crispum* (Hedw.) Hampe and *Weissia controversa* Hedw., followed by chromosome doubling.

### 3. **Tortella** (Lindb.) Limpr., *nom. cons.*

Plants small to medium-sized, in loose or dense, green, yellowish, or brown tufts. Stems erect, simple or forked, ± radiculose below. Leaves usually crisped and contorted when dry, erect-spreading or spreading from an erect, oblong base when moist, long-lanceolate, linear-lanceolate, or subulate, acute or obtuse, often apiculate; margins plane or erect, often incurved near the apex, often slightly and irregularly notched, somewhat undulate; costa strong, percurrent to excurrent, smooth at back, shiny and ± conspicuous when dry, with 2 stereid bands; upper cells rounded-hexagonal, green, obscure, densely papillose on both surfaces; lower cells laxly long-rectangular, delicate, hyaline, smooth, sharply set off from the upper cells in a V-shaped region extending above the shoulders as a short or fairly elongate border. Perichaetial leaves usually not much differentiated. Setae terminal, single, elongate, erect, becoming reddish with age; capsules erect and symmetric or somewhat curved, cylindric or ovoid-cylindric, smooth, greenish-yellow or yellow-brown; annulus present or lacking; operculum high-conic, ½ as long as the urn or more; stomata at extreme base of the capsule; peristome teeth inserted somewhat below the mouth, 16, split to a low basal membrane into 32 filiform, reddish, densely spiculose-papillose divisions which are wound together in 1-3 spirals (or rarely rudimentary or merely obliquely inclined). Calyptrae smooth, naked.—The name is a diminutive meaning twisted, in allusion to the twisted peristome teeth. The abrupt differentiation of the basal cells along a V-shaped line is the most obvious and useful character of the genus.

1. Leaves rigidly erect and not much contorted when dry, with long, linear, fragile tips
1. *T. fragilis*
1. Leaves spreading or incurved and strongly contorted when dry, not ending in a linear, fragile tip
2. Leaves gradually long-subulate, spirally contorted when dry 2. *T. tortuosa*
2. Leaves acute or obtuse and apiculate, irregularly incurved and contorted when dry
3. Autoicous; leaves only slightly keeled when moist, not cucullate at the apex 3. *T. humilis*
3. Dioicous; leaves keeled and cucullate even when moist 4. *T. inclinata*

1. **Tortella fragilis** (Hook. *ex* Drumm.) Limpr.—Plants in dense, rigid, green to brown or yellowish tufts up to 4.5 cm. high. Leaves erect-incurved and somewhat twisted around the stem when dry, erect-spreading when moist, about 4 or 5 mm. long, linear-lanceolate and long-subulate from a broader base, the subula thickened and mostly broken off; costa filling the subula; upper cells 9-11 $\mu$. Dioicous; perichaetial leaves not much differentiated. Setae 15-20 mm. long; capsules 1.8-3 mm. long; annulus none; peristome teeth long, spirally wound together. Spores about 9 $\mu$, minutely roughened or nearly smooth.

Grout, Mosses with Hand-lens and Microscope, Pl. 31.—**Fig. 280.**

On calcareous soil or rock (often in the crevice of cliffs), often on sand, logs, or other substrata near lakes and streams. Europe, North Africa, Asia; New Zealand (Campbell Island); Greenland to Alaska, south to New Jersey, the Great Lakes, Iowa, Colorado, and Oregon.

CHEBOYGAN CO.—Biological Station campus, Carp Creek, Iron Bridge. EMMET CO.—Arnott Lake, Cecil Bay, Big Stone Creek, Ramona Beach. MACKINAC CO.—St. Martins Point, Bush Bay. PRESQUE ISLE CO.—Evergreen Beach, Hammond Bay, Mast Point.

The rigid, fragile leaves which are not much contorted when dry are unmistakable.

2. **Tortella tortuosa** (Hedw.) Limpr.—Plants about 1-5.5 cm. high, in dense, green, yellow-green, or yellow-brown tufts. Leaves strongly contorted with spirally curled tips when dry, flexuose-spreading when moist, 4-6.5 mm. long, linear-lanceolate and gradually subulate-acuminate from a somewhat broader base, concave; costa excurrent as a long apiculus, yellowish (or rarely brownish); upper cells about 7-10 $\mu$. Dioicous; perichaetial leaves slender and erect at base, slenderly subulate. Setae 9-27 (rarely 35) mm. long; capsules 1.5-3.3 mm. long; annulus none; operculum 1.5-2 mm. long; peristome teeth long and spirally wound together. Spores 9-11 $\mu$, finely papillose or nearly smooth.—n = 13.

Conard, How to Know the Mosses, (ed. 2) fig. 94d. Darlington, Mosses of Michigan, fig. 53. Grout, Mosses with Hand-lens and Microscope, fig. 73.—**Fig. 281-283.**

On calcareous rock or soil, common on cliffs and boulders, also locally on sand near the Great Lakes. Circumpolar; Greenland to Alaska, south to Connecticut, Pennsylvania, the Great Lakes region, Iowa, Montana, and Oregon.

CHEBOYGAN CO.—Hermits Bog, Camp Knight and Fairy Island (Douglas Lake), Mill Creek, Grass Bay, Indian River. EMMET CO.—Arnott Lake, Ramona Beach, Five Mile Creek, Middle Village, Sturgeon Bay, Cecil Bay, Big Stone Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Bush Bay, Prentiss Bay, Ozark, Caffey Corner, Rexton. PRESQUE ISLE CO.—Mast Point, Evergreen Beach, Presque Isle lighthouse, Rainy River Falls, Ocqueoc Falls.

Robust for the genus. The long, subulate leaves spirally twisted and also curled at the tips when dry are highly distinctive. *Tortella tortuosa* sometimes has broken leaves, but it is only rarely confused with the much more rigid *T. fragilis*, in which the leaves are more or less erect, not much contorted when dry, and regularly broken.

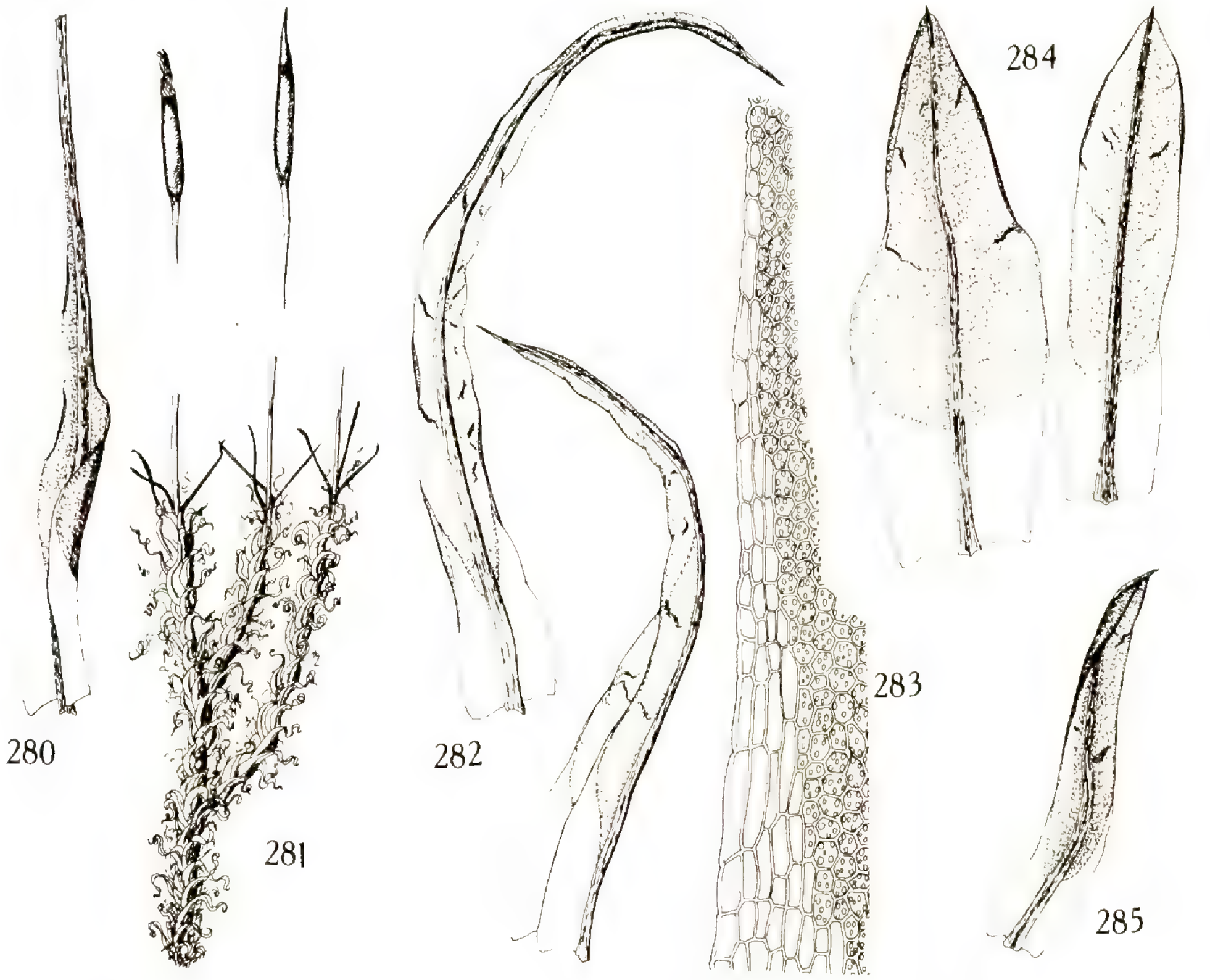
3. **Tortella humilis** (Hedw.) Jenn.–Rather small plants (about 5, rarely 10 mm. high), green, or yellow-green. Leaves curled and contorted when dry, spreading when moist, 2.2-3.5 mm. long, oblong-lanceolate from a broader base, narrowly to broadly acute, short-apiculate, concave, not cucullate; costa short-excurrent; upper cells 6-7 $\mu$. Autoicous; perigonia (often several) small and delicate, stalked, in axils of upper leaves; perichaetial leaves not much differentiated. Setae 7-18 mm. long; capsules 1.5-3 mm. long; annulus deciduous in fragments; operculum 1.2-1.5 mm. long; peristome teeth long, spirally wound together. Spores 7-11 $\mu$, finely roughened to nearly smooth.–n = 15, 26.

Conard, How to Know the Mosses, (ed. 2) fig. 94a-c. Grout, Mosses with Hand-lens and Microscope, Pl. 32 (as *T. caespitosa*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 13, (ed. 2) Pl. 17. Welch, Mosses of Indiana, fig. 71.–**Fig. 284.**

On bark at base of trees, rocks, soil, logs, and stumps in rather dry, partially shaded places; probably limited to calcareous habitats. Europe and North Africa; Haiti, Jamaica, Brazil, and the Galápagos Islands; British Columbia; reported from Arizona; widespread in eastern North America from Vermont and Ontario to Minnesota and the Gulf States.

CHEBOYGAN CO.–Fairy Island (Douglas Lake), Colonial Point, near Mud Lake. MACKINAC CO.–Ozark.

Rare locally. Best recognized by relatively broad (but not cucullate) acumina and autoicous inflorescences.




*Tortella fragilis.* 280. Leaf.
*Tortella tortuosa.* 281. Habit. 282. Leaves. 283. Cells at margin of leaf shoulder.
*Tortella humilis.* 284. Leaves.
*Tortella inclinata.* 285. Leaf.

4. **Tortella inclinata** (R. Hedw.) Limpr.–Rather small plants in yellowish or brown, usually dense tufts up to about 1 cm. high. Leaves incurved, twisted and somewhat curled when dry, rigidly erect or erect-spreading when moist, 2.2-3 mm. long, oblong-lanceolate and scarcely tapered from a somewhat broader base, broadly acute or obtuse and minutely apiculate, concave and cucullate; costa very shortly excurrent, brown; upper cells 7-10 $\mu$. Dioicous; perichaetial leaves conspicuously differentiated, yellow, elongate and erect at the base, curled at the tips when dry, narrowly lance-subulate with a long-excurrent costa. Setae 15-27 mm. long; capsules 1.5-2 mm. long; annulus none; operculum 1-2 mm. long; peristome teeth long, spirally wound together. Spores 7-11 $\mu$, smooth or finely roughened.

Grout, Moss Flora of North America 1: Pl. 84A (as *T. inclinatula*).–**Fig. 285.**

A calciphile growing on rock or soil, locally on sand in exposed places along the Great Lakes. Europe, Caucasus, and Persia; Alaska, British Columbia, Alberta, Michigan, Ontario, and Vermont.

EMMET CO.–Cross Village, Sturgeon Bay, Cecil Bay. MACKINAC CO.–12 mi. W. of St. Ignace. PRESQUE ISLE CO.–Mast Point, Lamprey Experiment Station, Evergreen Beach.

A rare species recognized by its occurrence on stabilized dune sands and by short, broad, cucullate leaf tips.

**Trichostomum tenuirostre** (Hook. & Tayl.) Lindb. (fig. 286-287), a rock-growing moss known from the Upper Peninsula, is similar to a *Tortella*, but the hyaline basal cells do not extend upward along the margins, and the peristome teeth are erect rather than spirally wound together. The leaf margins are usually somewhat wavy and often sinuate and irregularly notched. The chromosome number is recorded as n = 13.

## 4. **Bryoerythrophyllum** Chen

Plants small to rather robust, in loose or dense, green to yellowish, brownish, or red-brown tufts, usually brick-red below. Stems simple or forked. Leaves contorted when dry, erect-or wide-spreading from an erect base when moist, narrowly lanceolate to oblong-ligulate, broadly acute to apiculate, ± keeled; margins revolute in the lower ½ or more, often with a few irregular, pellucid teeth above; costa strong, subpercurrent or, more often, ending as a pellucid mucro, with 2 stereid bands; upper cells subquadrate or rounded-hexagonal, obscure, densely papillose on both surfaces, the papillae often C-shaped (rarely pale, smooth, and incrassate along the upper margins); lower cells rather conspicuously enlarged, oblong, lax, thin-walled, hyaline or red-brown and pellucid. Setae terminal, elongate, erect; capsules erect and symmetric or curved and inclined, cylindric or ovoid, smooth; annulus revoluble (at least in *B. recurvirostrum*); operculum conic to conic-rostrate; peristome teeth 16, erect, joined at base as a very low membrane, perforate along the median line or ± bifid, reddish, finely papillose. Calyptrae smooth, naked.–The name means red-leaved moss and refers to the brick-red color developed in many species of the genus. It was chosen to replace the name *Erythrophyllum*, which had been used previously for an alga. The genus is a segregate from *Didymodon* which, like *Barbula*, is the kind of catch-all that has been called a portemanteau (or coat-rack) genus. The large, lax, and thin-walled basal cells, the C-shaped papillae of upper cells, and the large annulus seem to justify segregation.

**Bryoerythrophyllum recurvirostrum** (Hedw.) Chen–Rather small plants (5-20, rarely 30 mm. high), in loose or dense tufts, green, yellow-green, or brown above, rusty or brick-red below. Leaves crisped and curled when dry, erect- or wide-spreading when

moist, 2-2.8 mm. long, oblong- to linear-lanceolate from an oblong, erect base, bluntly acute to apiculate; margins revolute in the lower 2/3 or nearly to the apex, often irregularly dentate near the apex; costa subpercurrent or (more often) shortly excurrent as a pellucid mucro; upper cells about 8 $\mu$ wide, subquadrate and hexagonal, firm-walled, with C-shaped papillae; lower cells hyaline to pale red-brown. Paroicous and synoicous. Setae 6-16 mm. long, red; capsules 1.3-2.5 or rarely 3 mm. long, erect and symmetric or occasionally slightly curved, cylindric, red-brown; annulus revoluble; operculum 0.5-1 mm. long, obliquely long-rostrate (or sometimes merely conic to short-rostrate); peristome teeth pale-brown or yellowish, linear-lanceolate, perforate or ± bifid, minutely papillose to nearly smooth. Spores 15-16 $\mu$, smooth or finely roughened.—n = 12+1, 13, 13+1.

Conard, How to Know the Mosses, (ed. 2) fig. 91a-d (as *Didymodon*). Darlington, Mosses of Michigan, fig. 57. Grout, Mosses with Hand-lens and Microscope, Pl. 27 (as *Didymodon rubellus*).—**Fig. 288-291.**

A common calciphile, usually on moist soil or rocks, often in disturbed, open situations (such as roadbanks), also flourishing in deep, undisturbed woods on wet logs, rotten stumps, etc. Europe, Asia, Africa, New Guinea, New Zealand; Greenland to Alaska, south to California, Arizona, Texas, Arkansas, and New Jersey; Mexico.

CHEBOYGAN CO.—Gorge of Carp Creek, Iron Bridge, Bryants Bog, Passino School, near Levering, Mill Creek. EMMET CO.—Middle Village, Cecil Bay, Big Stone Creek. MACKINAC CO.—Bois Blanc Island, Bush Bay, Detour, Ozark, Rexton. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Clinton Lake.

The lax, thin-walled basal cells and irregularly dentate margins near the leaf tips are distinctive. In the field, one can recognize the plants from the brick-red color sometimes demonstrable only at the base of the tufts, sometimes throughout.

## 5. **Didymodon** Hedw.

Plants slender to fairly robust, in loose or dense, dull, olive-green, brown, or red-brown tufts. Stems forked. Leaves ± erect and often contorted when dry, erect-spreading when moist, narrowly lanceolate and often subulate from a broader base; margins entire, generally revolute; costa strong, ending near the apex, often filling the subula and excurrent as a fleshy continuation of it, with 2 stereid bands; cells small, rounded-quadrate, usually obscure, smooth or bluntly papillose; lower cells short and firm, rectangular or somewhat elongate near the costa, yellowish or hyaline. Perichaetial leaves scarcely differentiated. Setae terminal, elongate, erect; capsules erect and symmetric, oblong-cylindric, smooth; annulus none or narrow and variously differentiated; operculum conic-rostrate; peristome teeth 16, erect or slightly oblique, joined at base, undivided or variously perforate, sometimes split nearly to the base into 2(or 3) filiform divisions, ± papillose. Calyptrae smooth, naked.—The name refers to twin divisions of the peristome teeth.

**Didymodon rigidulus** Hedw.—Rather small, dirty-green or yellow-brown, usually densely tufted plants up to 15 mm. high, commonly producing clusters of very small, brown, globose or rarely ovoid gemmae of 3-4 cells on branched stalks in upper leaf axils (especially when sterile). Leaves somewhat contorted when dry, erect- to wide-spreading when moist, 1-1.5 mm. long, lanceolate and gradually acuminate or subulate-acuminate to a slender, blunt, fleshy tip; margins recurved in the lower 1/2-2/3, entire or obscurely sinuate-notched and thickened above, the tip of the lamina also thickened; costa percurrent or disappearing in the fleshy apex, covered by short,

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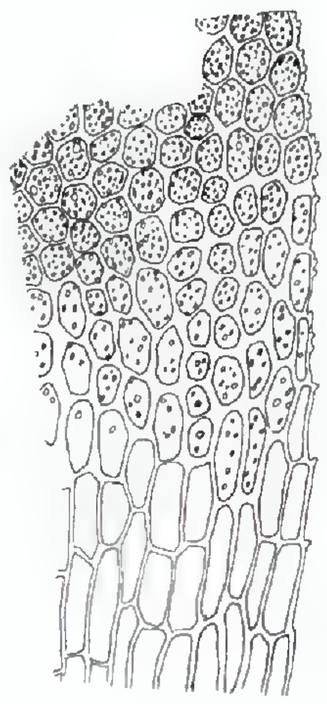

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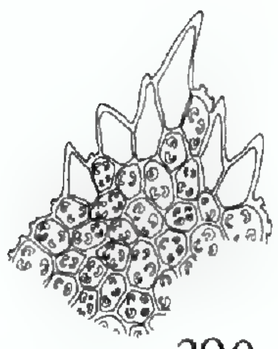

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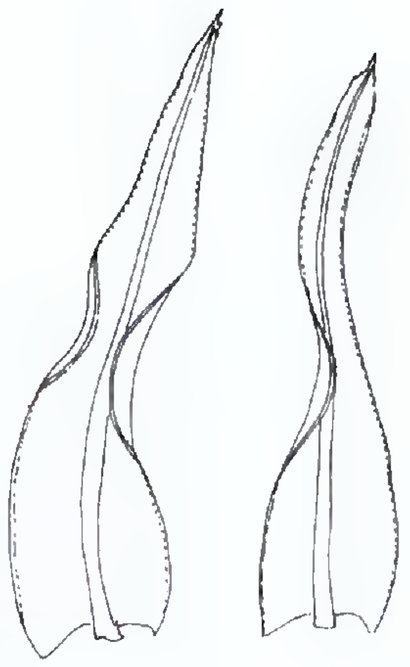

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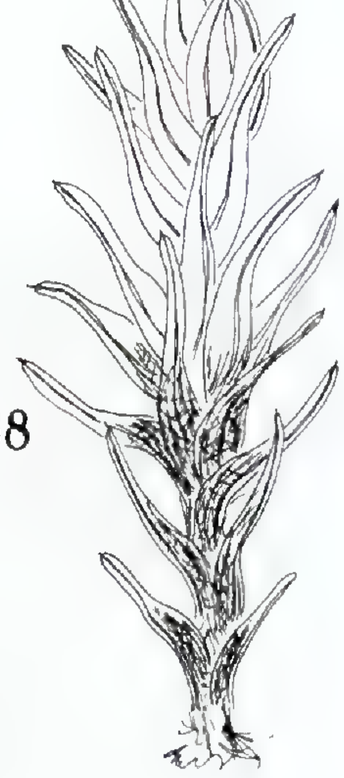

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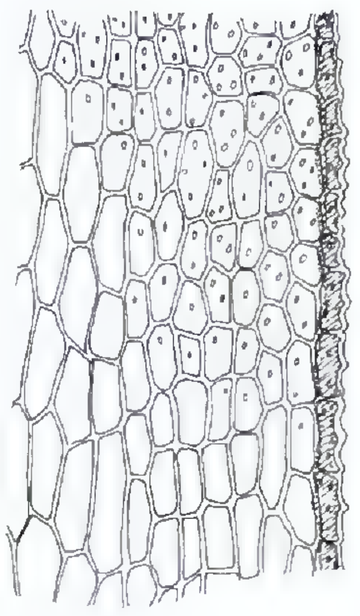

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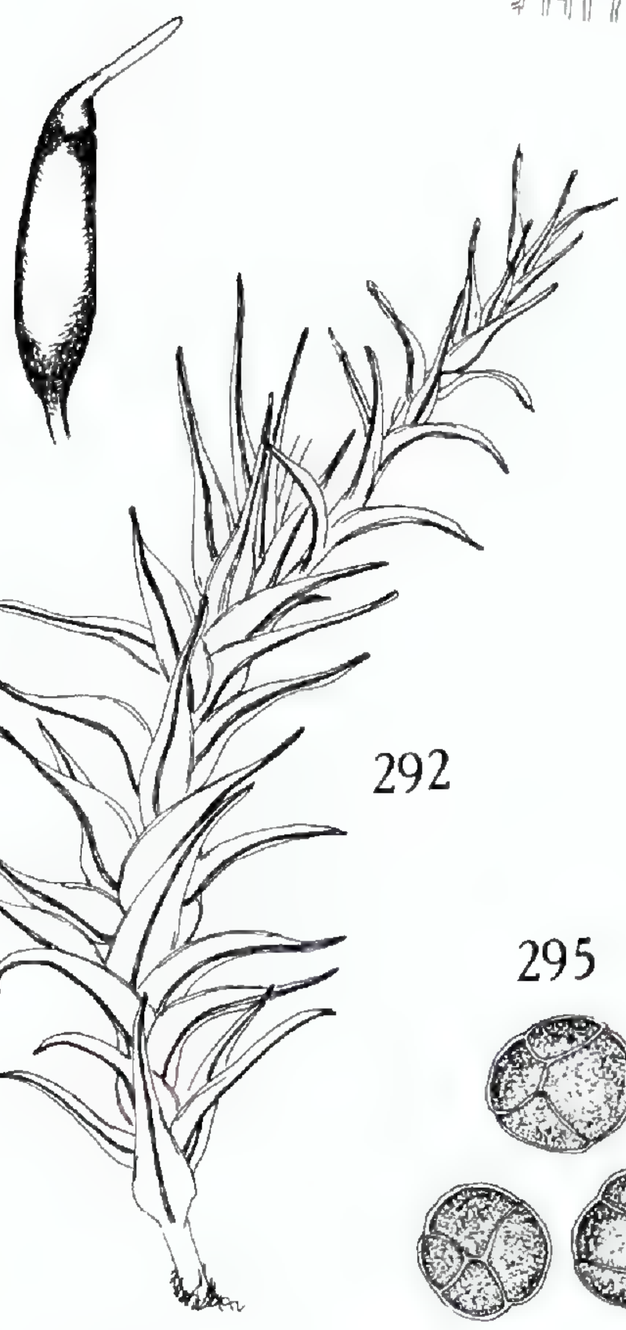

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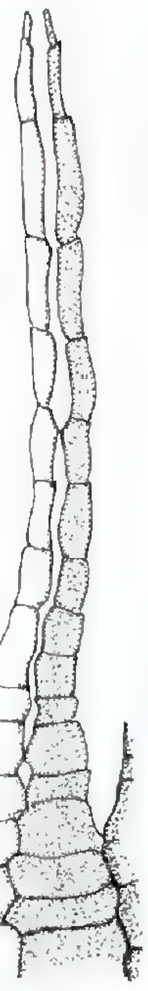

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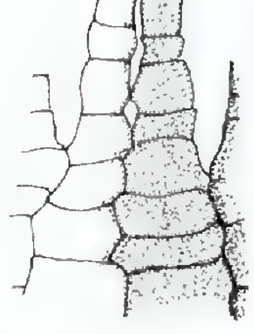

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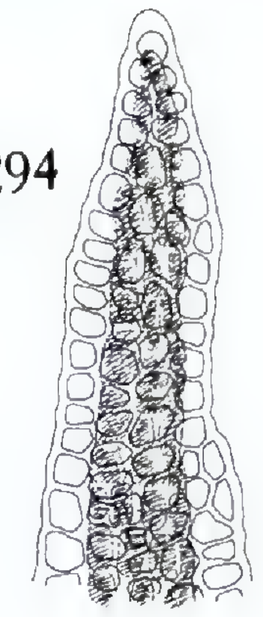


294

*Trichostomum tenuirostre.* 286. Leaves. 287. Cells at margin of leaf shoulder.

*Bryoerythrophyllum recurvirostrum.* 288. Habit. 289. Leaves. 290. Cells at leaf tip. 291. Cells of leaf base.

*Didymodon rigidulus.* 292. Habit. 293. Leaves. 294. Cells at leaf tip. 295. Brood-bodies. 296. Portion of peristome.

green cells in the upper half; upper cells about 8-10 $\mu$, irregularly rounded-quadrate, thick-walled, slightly and often obscurely papillose. Dioicous. Setae 5-13 mm. long, red; capsules 1-2 (rarely 2.5) mm. long, red-brown; operculum 0.6-0.9 mm. long, its cells in oblique rows; peristome teeth somewhat inclined, deeply and often irregularly bifid, yellow-brown, densely papillose. Spores 8-16 $\mu$, very finely roughened.—n = 12, 13.

Breen, Mosses of Florida, Pl. 40 (as *D. fuscoviridis*). Grout, Moss Flora of North America 1: Pl. 90B.—**Fig. 292-296.**

On damp or wet, calcareous rocks and soil, often on rocks in streams. Circumpolar; New Brunswick to Michigan and southward to Ohio, Tennessee, and Florida.

MACKINAC CO.–Mackinac Island, Bush Bay, Ozark. PRESQUE ISLE CO.–Rainy River Falls.

*Didymodon rigidulus* is a species of little character, best recognized by its axillary gemmae. Growing on calcareous rocks in and along streams, it often occurs with *Hyophila involuta* and *Fissidens obtusifolius* (neither known from our area). *Didymodon rigidulus* is similar in gametophytic appearance to *Barbula fallax,* which has elongate cells covering the costa in the upper part of the leaf.

**Didymodon tophaceus** (Brid.) Lisa (fig. 297-299) is a widely distributed species of wet, limey habitats. It has considerable variability but can be recognized by its decurrent leaves, a most unusual feature in the Pottiaceae. It is active in tufa formation, sometimes depositing around itself limey accretions which have been called didymodontoliths! Tufa is a soft limestone which on hardening becomes a porous, brownish stone called travertine. The Roman Coliseum was built of travertine (a word derived from the name of an ancient Roman town, now known as Tivoli). Not many years ago the more elegant American banks often had floors and staircases of travertine. (This was an elegance associated with the gleaming brass cuspidors once found in all public buildings.) Tufa is formed by photosynthetic plants removing carbon dioxide from waters charged with soluble calcium bicarbonate, causing the precipitation around them of insoluble calcium carbonate. *Didymodon tophaceus* has been found in Michigan but not locally, owing no doubt to a dearth of wet, calcareous habitats. Travertine formation by mosses in Oklahoma is described by Wilson & Guest (Okla. Geol. Notes 21: 310-316. 1961) and Emig (Bryol. 21: 25-27. 1918) and in Utah and Idaho by Flowers (Bryol. 36: 26-27. 1933). See also Berner (Rev. Bryol. et Lichén. 18: 59-65. 1949).

The chromosome number recorded for *Didymodon tophaceus* is n = 12.

**Hyophila involuta** (Hook.) Jaeg. & Sauerb. (fig. 300-304) has been collected on boulders along Au Train Bay, Lake Superior, in Alger Co. *H. involuta* is recognized with ease because of its habit, as well as its calcareous habitat. The oblong-spatulate leaves, crowded in a somewhat rosulate fashion at the stem tips, are rolled, incurved, and blackish when dry. The leaf margins are usually unevenly serrulate, and the upper cells are small, arranged in transverse rows, and bulging on the upper surface. Polymorphous brood bodies are commonly produced on branched stalks in leaf axils.

## 6. **Barbula** Hedw., *nom. cons.*

Plants small to medium-sized, gregarious or in dull, dark-green, brownish, or reddish tufts, simple or forked. Leaves usually larger toward the stem tips, erect and somewhat contorted when dry, narrowly lanceolate or oblong-ovate to lingulate, acute, obtuse, or rounded-obtuse, often apiculate; margins entire, nearly always revolute, sometimes to the apex or nearly so; costa subpercurrent to shortly excurrent, mostly with 2 stereid bands; upper cells rounded-quadrate, obscure, sometimes smooth but usually papillose on both surfaces (the papillae sometimes C-shaped); basal cells subquadrate to short-rectangular, hyaline or yellowish, and usually smooth. Dioicous; perichaetial leaves scarcely or strongly differentiated and convolute-sheathing. Setae terminal, erect, elongate, red or rarely yellow; capsules erect and symmetric or nearly so, oblong- or ovoid-cylindric; annulus none or, more often, present and persistent, rarely revoluble; operculum high-conic to long-rostrate; stomata few, at extreme base

of the urn; peristome (rarely lacking or rudimentary) inserted below the mouth, consisting of 16 teeth split to a low basal membrane into 32 filiform, papillose, reddish divisions which are spirally wound together. Calyptrae smooth, naked—The generic name means little beard, referring to the tufted peristome of 32 hair-like divisions. *Barbula* and *Didymodon* are separated for convenience on the basis of the peristome—long and twisted above a low basal membrane in *Barbula*, shorter and erect or merely obliquely inclined in *Didymodon*. Associated with twisted peristomes are a spiral arrangement of the cells of the operculum.

1. Leaves obtuse or broadly acute and minutely mucronate; margins slightly revolute near the base; inner perichaetial leaves enlarged, pale, sheathing, truncate or rounded to short-pointed; setae yellow ..... 1. *B. convoluta*
1. Leaves acute, not at all or stoutly apiculate; margins revolute in the lower 1/2-2/3 or more; perichaetial leaves scarcely differentiated; setae reddish
  2. Leaves broadly or bluntly acute, stoutly apiculate ..... 2. *B. unguiculata*
  2. Leaves acuminate and acute, not apiculate ..... 3. *B. fallax*

1. **Barbula convoluta** Hedw.—Small plants in dense, green or yellowish tufts up to 5, rarely 15 mm. high. Leaves incurved-contorted and somewhat spirally twisted around the stems when dry, erect-spreading when moist, about 0.8-1.2 mm. long, oblong-lanceolate or oblong-ligulate from a broader base, rounded-obtuse to broadly acute, minutely apiculate (at least in upper leaves); margins slightly revolute at base, plane above; costa ending at or just below the apex, with 2 stereid bands; upper cells densely papillose and obscure, rounded-quadrate or rounded-hexagonal, about 7-9 $\mu$ wide; lower cells shortly oblong, firm-walled, pale, smooth. Inner perichaetial leaves conspicuously enlarged, pale-yellow, convolute-sheathing, truncate to rounded or broadly pointed. Setae 10-20 mm. long, slender, bright-yellow to straw-colored, twisted when dry; capsules 1.2-1.8 mm. long, erect or slightly curved and inclined, sub-cylindric, slightly tapered from a broader base, very short-necked, light-brown, ± furrowed when dry and empty; annulus revoluble; operculum narrowly high-conic, slightly inclined, about 1 mm. long, its cells in oblique rows; peristome teeth dusty-pinkish. Spores 7-9 $\mu$, smooth.—n = 11, 13, 14.

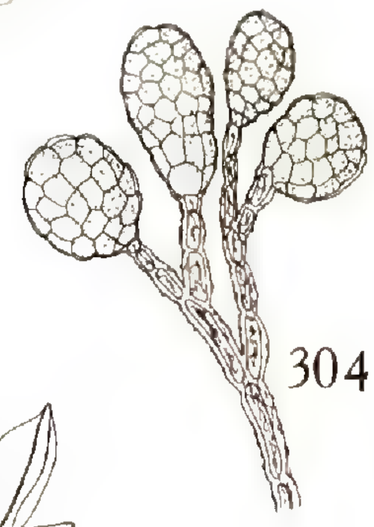
Darlington, Mosses of Michigan, fig. 56. Grout, Mosses with Hand-lens and Microscope, Pl. 28. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 13, (ed. 2) Pl. 17.—**Fig. 305-307.**

On bare, calcareous soil, often in open, disturbed places, common on roadbanks, along paths, and in old fields. Circumpolar; Alaska and British Columbia to New Brunswick, south to Baja California, Oklahoma, and Tennessee.

CHEBOYGAN CO.—Douglas Lake, Riggsville, Duncan Bay, Mill Creek, Afton Tower. EMMET CO.—Brutus, Alanson, Pellston Hills, Van, Levering, Sturgeon Bay, Cecil Bay, Big Stone Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island, Garnet, McKays Creek, Detour, Allenville, Ozark, Rexton. PRESQUE ISLE CO.—Ocqueoc Falls, Posen.

The yellow setae and distinctly differentiated perichaetial leaves are taxonomically useful.

2. **Barbula unguiculata** Hedw.—Plants in light- or dirty-green tufts 5-25 mm. high. Leaves erect and contorted when dry, erect-spreading when moist, 1-2 or 2.5 mm. long, oblong-lanceolate from an ovate base, blunt or broadly acute, abruptly apiculate; margins revolute in the lower 1/2-2/3; costa shortly excurrent, papillose at back, with 2 stereid bands; upper cells 8-10 $\mu$, rounded-hexagonal, ± thick-walled, pluripapillose on both surfaces; lower cells pale, smooth, rectangular, thin-walled. Dioicous. Setae 5-13 mm. long, reddish; capsules 1-2 mm. long; annulus none; operculum conic-



*Didymodon tophaceus.* 297. Leaves. 298. Cells at leaf tip. 299. Cells of leaf decurrency.

*Hyophila involuta.* 300. Habit. 301. Leaves. 302. Upper cells of two leaves. 303. Cross-section of leaf. 304. Brood-bodies.

*Barbula convoluta.* 305. Habit. 306. Leaves. 307. Upper cells of leaf.

*Barbula unguiculata.* 308. Habit. 309. Leaves. 310. Cells at leaf tip.

*Barbula fallax.* 311. Leaves. 312. Upper cells of leaf.

subulate; peristome reddish. Spores 9-13 $\mu$, smooth.—n = 11, 11+1, 12+1, 13, 13+1, 13+2, 14, 14+2, 24.

Conard, How to Know the Mosses, (ed. 2) fig. 92. Grout, Mosses with Hand-lens and Microscope, fig. 72. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 13, (ed. 2) Pl. 17. Welch, Mosses of Indiana, fig. 73.—**Fig. 308-310.**

On calcareous soil in disturbed places, particularly at roadsides and in old fields. Circumpolar; Alberta; widespread in the East from Nova Scotia to Minnesota, south to Florida and Louisiana.

CHEBOYGAN CO.–Biological Station Campus, Riggsville, Afton, Mill Creek, near Mackinaw City. EMMET CO.–Maple River, Pellston Hills, Conway Bog. MACKINAC CO.–Allenville, Hessel, Bois Blanc Island. PRESQUE ISLE CO.–Mast Point, Ocqueoc River, Posen.

The specific name refers to the apiculus, supposedly claw-like, which is particularly strong on upper and perichaetial leaves.

3. **Barbula fallax** Hedw.–Plants in brownish tufts 5-20 (rarely 40) mm. high. Leaves erect and ± incurved or contorted when dry, erect-spreading when moist, 1-2 mm. long, lanceolate or ovate-lanceolate, acuminate, acute; margins revolute in the lower half or nearly to the apex, with 2 stereid bands, not covered by short cells; upper cells 7-11 $\mu$, irregularly rounded-quadrate, oblate, and angular, thick-walled, with a single low, often bluntly forked papilla on either surface; lower cells pale, smooth, subquadrate to short-rectangular, moderately thick-walled. Setae 8-25 mm. long, red; capsules 1-2 mm. long; annulus none; operculum long, conic-subulate; peristome teeth dark- to orange-red. Spores 10-11 $\mu$, smooth.–n = 9, 10, 11, 13, 13+1.

Grout, Mosses with Hand-lens and Microscope, Pl. 29. Welch, Mosses of Indiana, fig. 74.–**Fig. 311-312.**

On moist calcareous soil, particularly on roadbanks. Circumpolar; Greenland; British Columbia; Nova Scotia to Minnesota and south to New York, Ohio, Missouri, and Louisiana.

CHEBOYGAN CO.–Biological Station campus, Camp Knight, Cheboygan, Afton, Mill Creek. EMMET CO.–Pellston Hills, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, McKays Creek, Rexton. PRESQUE ISLE CO.–Ocequeoc Falls, Mast Point, Posen.

The specific epithet means false or deceitful and seems appropriate because the species is a fooler, having little character and thus easily misidentified. The elongate cells covering the upper surface of the costa help in distinguishing this from *Didymodon rigidulus.*

**Barbula michiganensis** Steere was described from the Upper Peninsula, where it grows on sandstone cliffs above Lake Superior at Pictured Rocks in Alger County: Leaves ovate, acuminate, and acute; costa ending near the leaf apex, covered on the upper side by elongate cells; very small, spherical gemmae (20-30 $\mu$ in diameter and consisting of 2-6 cells) abundant in leaf axils. It can be identified readily on comparison with the illustrations in Grout's *Moss Flora,* vol. 1, plate 89A.

Similar to *B. fallax* in appearance, and also having elongate cells covering the costa, is **B. reflexa** (Brid.) Brid. It has leaves squarrose-recurved when moist and upper cells sharply papillose on both surfaces. It has been found in Ontario and elsewhere farther to the east.

## 7. **Phascum** Hedw.

Plants very small, simple or forked, scattered to gregarious. Leaves few, crowded, larger toward the stem tips, oblong-lanceolate to ovate or obovate, acute to acuminate and generally piliferous; margins usually entire, revolute; costa ending below the apex to excurrent, with a single, dorsal stereid band; upper cells subquadrate to hexagonal, pluripapillose (with C-shaped papillae) on 1 or both surfaces, or rarely smooth; lower cells lax, thin-walled, pale, smooth, rectangular. Perichaetial leaves not much differentiated. Setae very short, often curved; capsules immersed or shortly exserted, single

or sometimes paired, ellipsoidal to globose, bluntly apiculate; operculum and peristome none; stomata sometimes present. Calyptra small or minute, cucullate or rarely mitrate.—A name used by Theophrastus for a lichen, supposedly *Usnea barbata,* and applied to mosses by Linnaeus in a sense which also included modern genera as diverse as *Cryphaea* and *Splachnum.* Schreber, in 1770, in restricting the name to a more modern sense appropriately quoted the ancients as saying that nature is never more perfect than in small things—a statement rendered more meaningful to his contemporaries by the increasing use of lenses. (In those times a lens was a *Flohglas* used in searching for fleas!) Speaking of things small, Stark (in *A Popular History of British Mosses,* 1860) brought out of the *Edinburgh Encyclopaedia* an apt remark: "It has been observed by a writer equally elegant and profound (Pascal) that 'Man is placed in the middle between two infinities—the infinitely great and the infinitely little—both of which are incomprehensible to him.'"

**Phascum cuspidatum** Hedw.—Small, green to yellow-brown plants 2-4 mm. high. Leaves curved and contorted when dry, erect or erect-spreading when moist, keeled, about 2-3.5 mm. long, oblong-lanceolate to oblong-obovate, acute to acuminate and ending in a pale-yellowish, smooth awn of varying length; margins revolute along the middle, sometimes nearly to the apex, entire; costa excurrent, brownish, smooth; upper cells subquadrate to hexagonal, sometimes slightly elongate, about 13-18$\mu$ wide, smooth or more commonly with numerous C-shaped papillae on both surfaces (occasionally less papillose at the margins in an indistinct border). Autoicous. Setae very short, ± curved; capsules immersed, pale-brown, shiny, 1-1.5 mm. long, ellipsoidal or sometimes globose, stoutly and bluntly apiculate; stomata in 1 row at base of the capsule. Spores spherical and slightly elongate, 22-44 $\mu$, brown, densely papillose to tuberculate. Calyptra rather small to medium-sized, cucullate, smooth, naked.—n = 21, 26, 28, 29, 42, 52 (var. *americanum,* n = 26, 27+1-2, 28+1-2, 29-30).

Conard, How to Know the Mosses, (ed. 1) fig. 48c & (ed. 2) fig. 75c (as var. *americanum*). Darlington, Mosses of Michigan, fig. 59. Grout, Mosses with Hand-lens and Microscope, fig. 68, Moss Flora of North America 1: Pl. 91C (as var. *americanum*).—**Fig. 313-315.**

On limey soil in old fields, pastures, and other grassy places, at roadsides, for example, in winter and spring (November-May). Not yet found in the Straits counties, no doubt because of its late appearance, which is out of phase with the botanical activity associated with the Biological Station. Europe, North Africa, and the Caucasus; British Columbia to California, and Utah, across the continent to Quebec, and widespread in the eastern United States.

**Phascum floerkeanum** Web. & Mohr, found in several localities in southern Ontario, may well occur in Michigan. The plants, though minute, stand out because of their red-brown color. The leaves are only 1 mm. long, or less, concave, ovate, and reddish-awned, and the upper cells of the leaf are 11-14 $\mu$ in diameter. The inflorescences are paroicous, the spores yellowish and nearly smooth, and the calyptrae mitrate. The species grows on bare patches of calcareous soil in old fields and other disturbed places and matures its fruits between October and April.

## 8. **Pottia** (Reich.) Fürnr.

Very small, scattered or gregarious plants. Leaves generally larger and more crowded at the stem tips, erect to spreading, ± concave or keeled, oblong-ovate, oblong-lanceolate, or lingulate, apiculate to awned, rarely rounded at the apex; margins plane or recurved, sometimes crenulate or serrulate above; costa mostly percurrent to excurrent, with dorsal stereids only; upper cells hexagonal, pluripapillose on both surfaces or rarely smooth; lower cells pale, smooth, oblong. Perichaetial leaves generally

not differentiated. Setae mostly ± elongate; capsules usually exserted, erect and symmetric, sometimes wide-mouthed, usually with a short neck; annulus present or lacking; operculum low-convex to conic, short-pointed to rostrate; peristome often none or rudimentary, sometimes consisting of 16 irregularly 2-3-forked or perforate (or sometimes entire), erect teeth from a low basal membrane inserted at the mouth. Calyptrae cucullate, smooth or papillose, naked.—Named for Johann Friedrich Pott, a professor of botany in Braunschweig.

Plants red-brown, up to 2 mm. high, not rosulate; leaves 1-1.5 mm. long, lanceolate to ovate-lanceolate, ending in a reddish apiculus or awn; upper cells of leaves 12-15 $\mu$, densely papillose; annulus none; operculum short-pointed; spores spinulose; calyptra finely papillose ..... 1. *P. davalliana*

Plants greenish or yellow-brown, up to 5 mm. high, ± rosulate; leaves 1.5-3 mm. long, oblong-lanceolate to obovate, ending in a yellow-brown apiculus or awn; upper cells 15-22 $\mu$, smooth (or occasionally indistinctly papillose); annulus of 1 row of cells, persistent; operculum rostrate; spores finely papillose; calyptra smooth ..... 2. *P. truncata*

1. **Pottia davalliana** (Sm. *ex* Drake) C. Jens.—Plants up to about 2 mm. high, red-brown. Leaves erect and not much contorted when dry, erect-spreading when moist, 1-1.6 mm. long, ovate-lanceolate or lanceolate, gradually acuminate, acute, ending in a strong, red or red-brown apiculus or short awn; margins entire, revolute below, sometimes nearly to the apex; costa excurrent; upper cells hexagonal, 12-15 $\mu$ wide, densely papillose (with C-shaped papillae). Paroicous. Setae 1.5-3 mm. long, yellowish, slender and ± flexuose; capsules 0.4-1 mm. long, short-oval to hemispheric, usually wide-mouthed when dry and empty, brown, thin-walled, vertically striate-wrinkled when dry; annulus none; operculum low-conic, shortly and obliquely pointed; peristome none. Spores 29-33 $\mu$, somewhat ellipsoidal, densely spinulose, yellow-brown. Calyptrae delicately papillose throughout.—n = 27+1, 28, 30.

Williams, Bryol. 64: 49, figs. 1-8.—**Fig. 316-318.**

A pioneer species found on bare spots of calcareous soil of old fields (especially second-year stubble fields), pastures, lawns, and roadsides; a fall ephemeral, sometimes also appearing in the summer under conditions of unusual moisture. Europe, North Africa, Madeira; Ontario and Michigan.

EMMET CO.—Brutus. PRESQUE ISLE CO.—Posen.

The sterile plants can be spotted in the field by their red-brown color and resemblance to scattered plants of *Ceratodon purpureus* in miniature. (It is coincidental that they grow in places where one also finds such a weed as *Ceratodon*.)

2. **Pottia truncata** (Hedw.) Fürnr. *ex* BSG.—Plants about 3-5 mm. high, green to yellowish or brownish. Leaves larger and more crowded toward the stem tips, 1.5-2.5, rarely 3 mm. long, erect or erect-spreading and somewhat contorted when dry, erect-spreading when moist, oblong-lanceolate to oblong-ovate or obovate, acute or acuminate, ending in a smooth, yellow-brown, stout apiculus or awn; margins plane (or sometimes ± recurved at the middle), entire or slightly crenulate near the apex; costa short- to long-excurrent; upper cells irregularly hexagonal to short-rhombic, 15-22 $\mu$ wide, firm-walled, smooth or occasionally indistinctly papillose at back. Autoicous (or paroicous, the antheridia naked in axils of upper leaves). Setae 2-5, rarely 8 mm. long, orange- to red-brown; capsules 0.5-1.5 mm. long, obovoid or obconic and becoming wide-mouthed when dry and empty, brown, thin-walled, finely wrinkled-striate when dry; annulus of 1 row of cells, persistent; operculum obliquely long-rostrate from a convex-conic base; peristome lacking (or occasionally rudimentary, delicate, and papillose). Spores 22-32 $\mu$, spherical or nearly so, finely papillose.—n = 20, 25, 26, 52.

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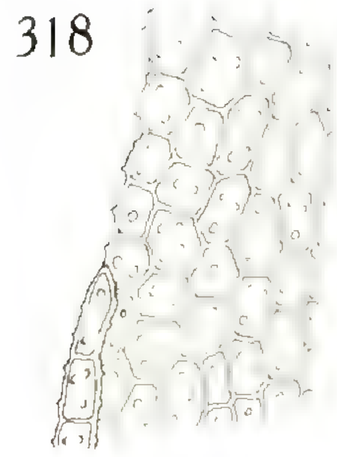

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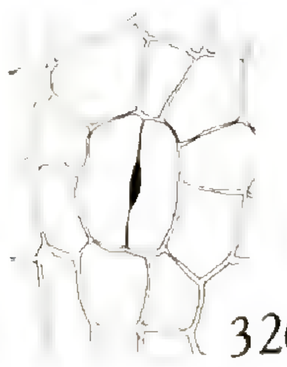

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*Phascum cuspidatum*. 313. Habit. 314. Leaves. 315. Upper cells of leaf.
*Pottia davalliana*. 316. Habit. 317. Leaves. 318. Cells of upper portion of leaf.
*Pottia truncata*. 319. Habit. 320. Leaves. 321. Cells of upper portion of leaf.
*Desmatodon obtusifolius*. 322. Habit. 323. Leaves. 324. Upper cells at leaf margin. 325. Portion of peristome and annulus. 326. Stomate.

Conard, How to Know the Mosses, (ed. 2) fig. 142. Darlington, Mosses of Michigan, fig. 60. Grout, Mosses with Hand-lens and Microscope, Pl. 33 (as *P. truncatula*), Moss Flora of North America 1: Pl. 95 (figs. 20-21). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 13, (ed. 2) Pl. 17.–**Fig. 319-321.**

A fall ephemeral (sometimes appearing in the summer under unusually moist conditions), on bare spots of calcareous soil in fallow fields (especially second-year clover, alfalfa, or hay fields), pastures, meadows, roadside ditches, etc. Europe, North Africa, Asia, Canary Islands; Uruguay; Australia; Washington and British Columbia; Nova Scotia to Ontario and Michigan, south to Maryland.

CHEBOYGAN CO.–Tower. EMMET CO.–Galloway Lake, Brutus. MACKINAC CO.–Allenville.

Much smaller but similar in aspect, both gametophytically and sporophytically, to *Physcomitrium pyriforme.* The excurrent costa of *Pottia truncata* will help in distinguishing the two. Also, *Physcomitrium pyriforme* fruits in the spring, *Pottia truncata* in the fall.

The var. **major** (Web. & Mohr) BSG (n = 52), also known as *P. intermedia* (Turn.) Fürnr., has been found in Ontario. The plants are somewhat larger, with leaf margins usually more strongly recurved. The capsules are somewhat longer (1-1.2, rarely 1.5 mm. long), oblong-cylindric, not wide at the mouth or tapered to the base.–The differences are discussed and illustrated by Saito (Bull. Nat. Sci. Mus. Tokyo 16: 60-91. 1973–see especially fig. 1, 2).

## 9. **Desmatodon** Brid.

Small plants in usually dense, green to yellow tufts. Stems simple or forked. Leaves crowded, erect and often flexuose or contorted when dry, erect-spreading when moist, concave or keeled-concave, oblong-ovate or oblong-lanceolate to obovate, acute or obtuse, usually apiculate or hair-pointed; margins usually revolute below, sometimes nearly to the apex, often serrulate toward the apex, frequently bordered by linear cells below, often by short, yellowish, incrassate cells above; costa subpercurrent to excurrent, with a dorsal stereid band and covered ventrally by a layer of large, often papillose cells; upper cells hexagonal or oblong-hexagonal, thin-walled, smooth or more commonly pluripapillose (with C-shaped papillae); lower cells lax, thin-walled, rectangular, smooth, hyaline. Perichaetial leaves not much differentiated. Setae elongate, erect, usually twisted when dry, smooth; capsules mostly erect, symmetric and oblong-cylindric to narrowly cylindric, sometimes broadly oblong, asymmetric and strongly inclined, smooth or finely wrinkled-striate; annulus present, usually persistent; operculum conic, short- to long-rostrate, often obliquely so, its cells mostly in oblique rows; stomata in 1 row at extreme base of the capsule; peristome inserted somewhat below the mouth, split nearly to a low membrane into 2-3 filiform, papillose divisions which are sometimes irregularly joined above, often ± obliquely inclined or slightly wound together, rarely none or rudimentary. Spores small, spherical, and smooth or large, shortly ellipsoidal, and roughened. Calyptrae smooth, naked.–Bridel applied the name, in an ininspired way, in reference to a narrow band formed by the fusion of peristome teeth into a low basal membrane. (The basal membrane of *Tortula* is so much more striking, that any emphasis on that of *Desmatodon* seems unfortunate!)

**Desmatodon obtusifolius** (Schwaegr.) Schimp.–Plants dull-green, gregarious or caespitose, about 3-6 mm. high. Leaves erect-spreading when moist, ± incurved-contorted when dry, 1.2-2 mm. long, oblong, oblong-lanceolate, or ovate-lanceolate, rounded-obtuse, often apiculate (uppermost leaves rarely short-awned); margins entire, revolute from near the base almost to the apex, sometimes strongly so; costa terete, subpercurrent, sometimes disappearing in the pale apiculus; upper cells 8-11 $\mu$ wide, irregularly hexagonal, obscure, densely papillose, usually not differentiated at the margins but sometimes somewhat paler and more incrassate. Autoicous (but usually appearing dioicous). Setae 6-12 mm. long; capsules (1)1.5-2(2.5) mm. long, narrowly (or rarely broadly) cylindric, erect or sometimes slightly curved, finely wrinkled-striate when dry and empty; operculum 0.5-0.6 mm. high, stoutly conic, sometimes conic-rostrate and ± inclined, its cells in oblique rows; peristome teeth whitish to pale

orange-red, rather weakly developed, about 140-275 $\mu$ high, irregularly divided into 2 slender prongs of unequal length. Spores 8-11(16) $\mu$, greenish-yellow, smooth, spherical.—n = 26.

Conard, How to Know the Mosses, (ed. 2) fig. 82a-c. Darlington, Mosses of Michigan, fig. 61. Grout, Mosses with Hand-lens and Microscope, Pl. 34 (as *D. arenaceus*), Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 13 (as *D. arenaceus*), (ed. 2) Pl. 17. Welch, Mosses of Indiana, fig. 80.—**Fig. 322-326.**

On damp, shaded rock, on cliffs or boulders, stone walls, bridge supports, etc., rarely on soil; mostly commonly on sandstone, but probably preferring limey substrates. Europe; Caucasus and Asia Minor; Greenland; Alaska to New Brunswick, south to California, Colorado, Texas, and Tennessee.

CHEBOYGAN CO.—Mill Creek. MACKINAC CO.—Mackinac Island.

## 10. **Tortula** Hedw., *nom. cons.*

Plants small to large, in dull, green, glaucous-green, or brownish tufts, rarely scattered, often tinged with red, simple or forked, usually radiculose below. Leaves often larger and more crowded at the stem tips, sometimes in rosulate clusters, erect- to wide-spreading or squarrose to recurved when moist, usually erect, folded lengthwise and twisted around the stem when dry, lingulate, obovate or elliptic (usually widest above the middle), broadly rounded or obtuse, rarely acute, often apiculate or awned; margins usually entire, occasionally bordered by short, incrassate, pale or colored cells or by linear cells, nearly always revolute throughout or in part; costa usually strong, often terete, mostly percurrent to excurrent, with dorsal stereids only; upper cells hexagonal, thick-walled, usually strongly pluripapillose and obscure (rarely smooth or weakly papillose), the papillae mostly circular or C-shaped; lower cells usually large, rectangular, lax, thin-walled, smooth and hyaline, yellow-brown or reddish, usually in rather abruptly differentiated groups. Perichaetial leaves mostly not or slightly differentiated. Setae terminal, single, elongate, erect; capsules cylindric to ovoid-cylindric, erect and symmetric or somewhat curved; annulus persistent or revoluble; operculum narrowly conic or conic-rostrate; peristome teeth 16 (rarely lacking), inserted below the mouth, usually long, divided to a basal membrane of varying length (generally a high, tesselated tube) into 32 filiform, papillose teeth typically wound together in 1-several spirals. Calyptrae smooth, naked.—The name (like *Tortella*) is a diminutive meaning twisted, in reference to the long, twisted peristome teeth. In England, *Tortula* has been called, for similar reasons, the SCREW MOSS. The basal membrane of the peristome is, in most species, very high and marked off in a curious pattern of squares.

Leaves erect-spreading when moist, acute to subulate-acuminate; cells smooth or weakly papillose ..... 1. *T. mucronifolia*
Leaves squarrose-recurved when moist, ending in a hyaline hair-point; cells densely papillose ..... 2. *T. ruralis*

1. **Tortula mucronifolia** Schwaegr.—Plants loosely tufted or mixed with other mosses, dull, dark-green, sometimes tinged with yellow or brown, 5-15 mm. high. Leaves keeled and contorted when dry, erect-spreading when moist, 2.5-3.5, rarely 5 mm. long, oblong or oblong-obovate, acute or acuminate; margins revolute in the lower 1/2-2/3; costa excurrent as a stout, yellow mucro or hair-point; upper cells (13)16-21(28) $\mu$ wide, irregularly subquadrate and rounded-hexagonal, with firm, yellowish walls ± thickened at the corners, smooth or nearly so, smaller and more incrassate near the margins, often forming a ± distinct border of short, yellowish cells; basal cells elongate-rectangular, not sharply delimited. Autoicous. Setae 8-22 mm. long;

capsules (2)3.5-4.5 mm. long, erect but usually somewhat curved, narrowly cylindric; annulus persistent; operculum 1.8-2.4 mm. long, erect, conic-subulate; peristome teeth long, the basal membrane pale, pinkish or orange, becoming white with age, about as long as the teeth which are closely wound together and orange or rarely pink. Spores 11-15 $\mu$, very finely papillose.–n = 12, 24, 26, 30.

Conard, How to Know the Mosses, (ed. 2) fig. 146. Grout, Mosses with Hand-lens and Microscope, Pl. 36. Welch, Mosses of Indiana, fig. 81.–**Fig. 327-329.**

On calcareous soil in crevices of cliffs and boulders and frequently in sheltered niches on banks or on and among rocks. Circumpolar; Greenland to Alaska, south to New York, the Great Lakes, Iowa, New Mexico, and California.

CHEBOYGAN CO.–Fairy Island (Douglas Lake), Colonial Point, Mill Creek. EMMET CO.–Middle Village, Cross Village, Cecil Bay.

The nearly smooth upper cells and the poorly delimited basal cells are distinctive, in a negative way, as compared with most species of *Tortula.*

2. **Tortula ruralis** (Hedw.) Gärtn., Meyer & Scherb.–Rather small to moderately robust plants in loose or dense, hoary tufts, often blackish when dry, typically reddish below and bright-green above when moist. Leaves loosely appressed, folded, and somewhat twisted around the stem when dry, wide-spreading to squarrose-recurved when moist, 3-4 mm. long (including the awn), keeled, oblong, obtuse or rounded-obtuse and ending abruptly in a long, white, spinulose awn (± reddish at base); margins revolute nearly to the apex; costa red or brown, densely spiculose at back; upper cells 9-13 $\mu$, green and often opaque, densely papillose on both surfaces, with C-shaped papillae. Dioicous. Setae 10-18 mm. long; capsules 2.5-3 mm. long, long-cylindric, sometimes slightly curved; annulus persistent; operculum high-conic; peristome teeth long, twisted above a high basal membrane, yellowish to salmon-pinkish. Spores 7-11 $\mu$, very finely roughened.–n = 12 (and, as *T. intermedia,* n = 12, 13, 13+1, 23+2, 28+2.

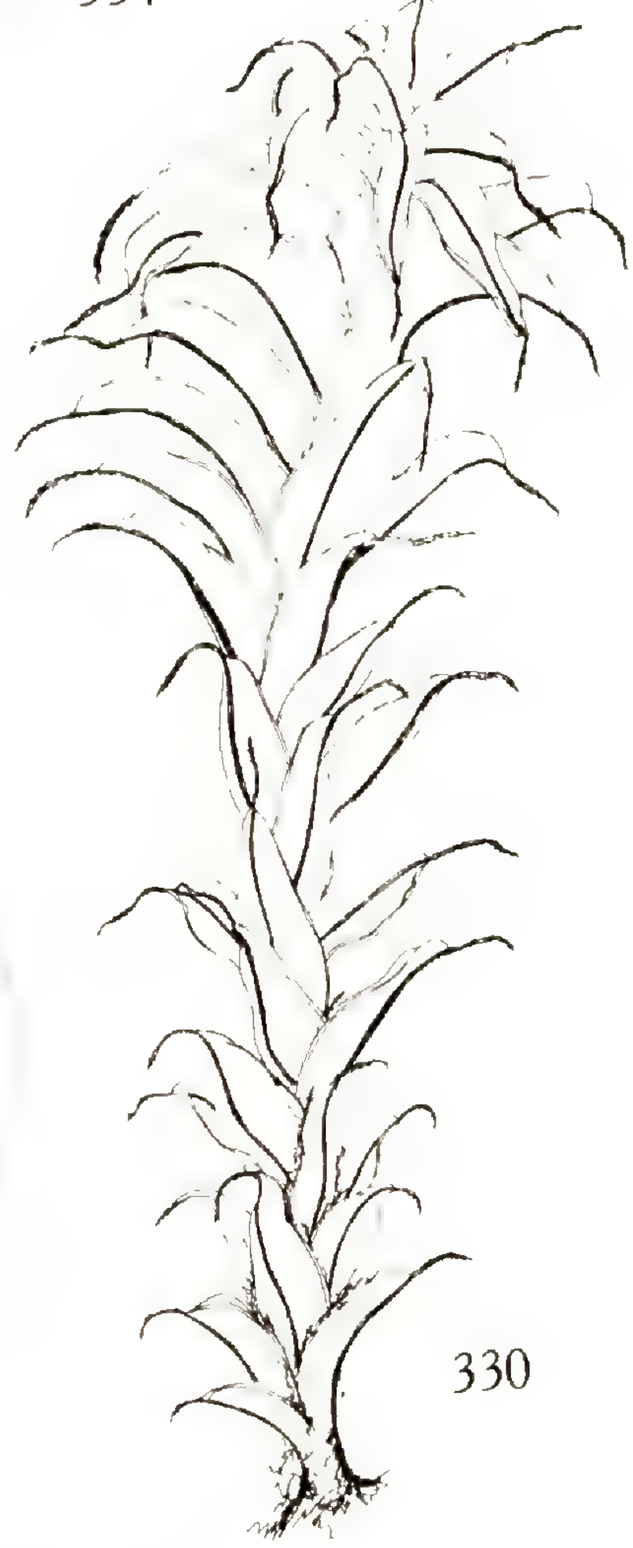
Conard, How to Know the Mosses, (ed. 2) fig. 83d-e. Darlington, Mosses of Michigan, fig. 62. Grout, Mosses with Hand-lens and Microscope, Pl. 35. Welch, Mosses of Indiana, fig. 83.–**Fig. 330-332.**

On soil or rocks in dry, sunny, calcareous habitats, locally common on sand along the shores of the Great Lakes. Circumpolar; throughout much of North America.

CHEBOYGAN CO.–Biological Station campus, Colonial Point, Mill Creek, Indian River. EMMET CO.–Cross Village, Middle Village, Five Mile Creek, Ramona Beach, Cecil Bay, Big Stone Bay, Waugoshance Point. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Bay, McKays Creek, Bush Bay, Epoufette, Ozark, Caffey Corner. PRESQUE ISLE CO.–Hammond Bay, Hoeft State Park, Bells Landing, Mast Point, Rainy River Falls.

Locally common as a sand-binding species, especially along shores of the Great Lakes. *Tortula ruralis* is a pronounced calciphile, easily recognized by the brick-red color of the plants, at least in the older parts, and by the leaves which are squarrose-recurved when moist. The high, checkered membrane of the peristome, the laxly oblong basal cells in rather well-marked groups rounded above, and the circular and C-shaped papillae are characteristic of most species of *Tortula.*

Some of our material in eastern North America may be **T. intermedia** (Brid.) Berk. (= *T. ruralis* var. *crinita* De Not.). A decision requires a re-evaluation of a circle of confusion centered around *T. ruralis.* As Steere, in Grout's *Moss Flora,* said: "This species is most apt to be taken for an underdeveloped form of *T. ruralis,* from which it may be distinguished by the darker color, the spreading, but not squarrose leaves, the leaf margins plane above, the smaller leaf cells, and the more emarginate leaf apex."



*Tortula mucronifolia.* 327. Habit. 328. Leaves. 329. Upper cells of leaf.
*Tortula ruralis.* 330. Habit. 331. Leaves. 332. Upper cells of leaf.
*Tortula papillosa.* 333. Habit. 334. Leaves. 335. Upper cells of leaf.

**Tortula norvegica** (Web.) Wahl. *ex* Lindb. is a western, montane species much like *T. ruralis.* It is characterized by a lightly roughened costa which projects as a slender, shiny, red, nearly smooth awn. It has been found once in Michigan, on Summer Island in Delta County. It is a calciphile.

**Tortula papillosa** Wils. *ex* Spruce (fig. 333-335) is a small moss growing scattered on trunks of trees (and especially on bark at base of roadside elms and maples). It has oblong-obovate, rounded-obtuse, abruptly piliferous leaves bearing an abundance of globose, multicellular gemmae on the upper surface of the costa. Its cells are smooth or unipapillose. It has been found in more southerly parts of the state.

**Tortula pagorum** (Milde) De Not., also small and scattered on bark of trees, has not yet been found in Michigan. It is widespread throughout much of the eastern United States, where it is associated with the activities of man, being found most

commonly in towns and elsewhere near habitations. It is no doubt an introduced species, as only female plants have been found in eastern North America; only male plants occur in Europe. (Fruiting plants have been found in Australia.) Anderson's systematic study of the American distribution (Bryol. 46: 47-66. 1943) is worth noting as an example of biologically interesting information gleaned from floristic study. *Tortula pagorum* has hyaline awns on its leaves, densely papillose cells, and leaf-like propagula in the leaf axils.

**Acaulon muticum** (Hedw.) C. M. var. **rufescens** (Jaeg.) Crum is a minute moss which is widespread in eastern North America and might be discovered locally in ephemeral situations, such as sandy or clayey soil in old fields, vacant lots, or mowed grass at roadsides, in winter and spring. The plants are only 1-2 mm. high, bulbiform, yellowish to reddish-brown, not trigonous; leaves 1-2 mm. long, concave but not keeled, broad and oblong-ovate to elliptic, cuspidate-apiculate and recurved at the tip; margins recurved near apex of leaf; costa narrow, brown, subpercurrent or shortly excurrent; upper cells 2-3 : 1, smooth. Capsules immersed, spherical, without operculum or peristome. Spores spherical, 30-52 $\mu$, yellowish, smooth.

*Aloina rigida* (Hedw.) Limpr. and *A. brevirostris* (Hook. & Grev.) Kindb. (fig. 336-337) may yet be discovered in Michigan. They are pioneers of bare, limey silt, especially on road banks and river bluffs. They resemble an *Aloë* in miniature because of fleshy, concave leaves. The costa is hidden below a mass of green, branched filaments. The two species may be distinguished, as follows: **A. rigida**—leaves 1.5-2.5 mm. long, oblong-lingulate; upper cells 3-4:1; capsules 1.8-2.5 mm. long, narrowly cylindric; operculum long and narrow and usually erect. **A. brevirostris**—leaves 1 or rarely as much as 1.8 mm. long, suborbicular to broadly lingulate; upper cells 1-3:1; capsules 1-2 mm. long, broadly cylindric to ovoid-cylindric; operculum short-rostrate and oblique.

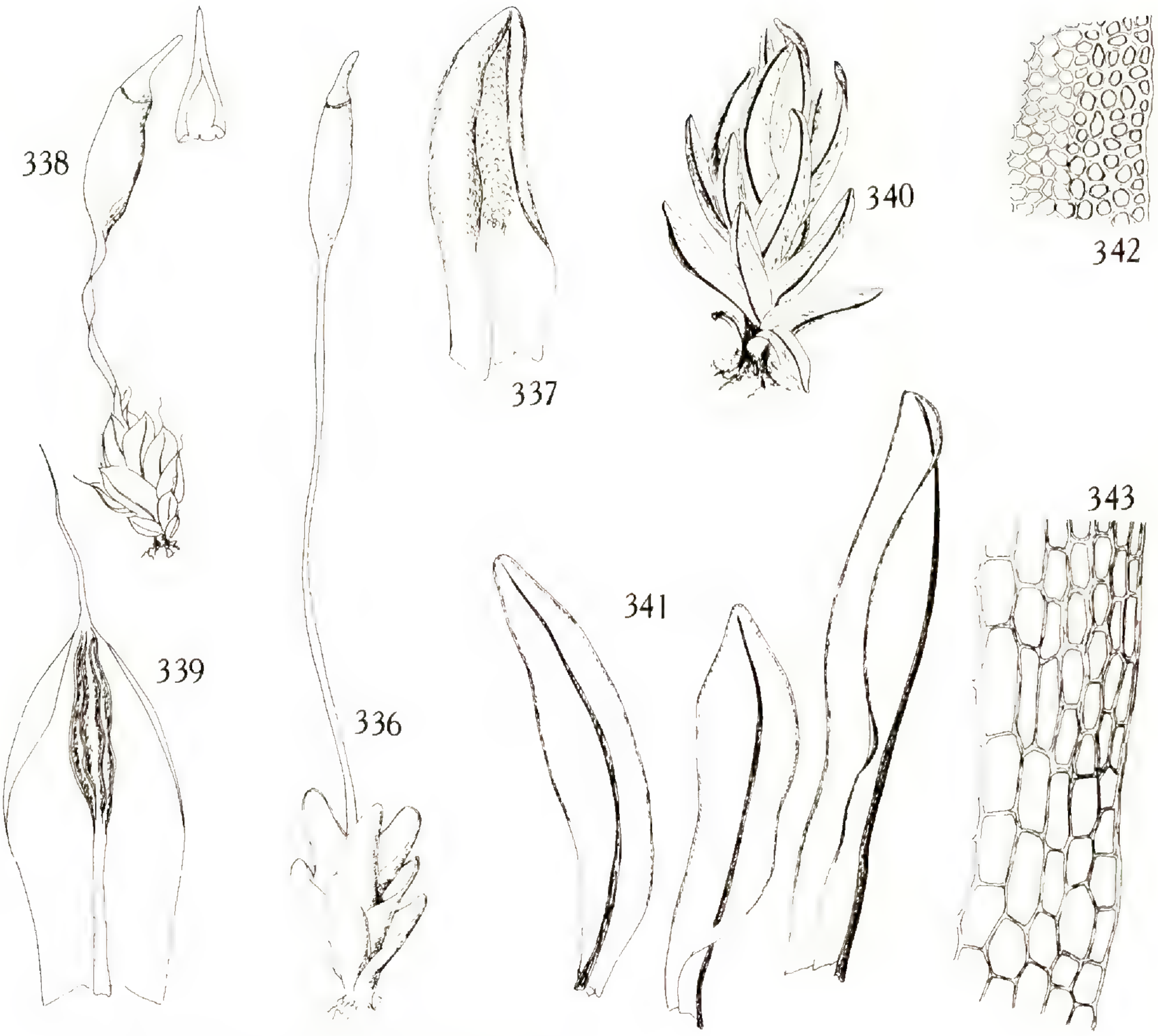
**Pterygoneurum ovatum** (Hedw.) Dix. (fig. 338-339) should be sought for on bare patches of calcareous soil in lawns, pastures, and clover fields. It is best known by the lamellae borne on the upper surface of the costa.

**Scopelophila ligulata** (Spruce) Spruce (fig. 340-343), a rock-growing moss somewhat resembling a *Tortula* (also known as *Merceya*), has been found once in Michigan's Upper Peninsula. It has usually been found on copper-bearing rocks and is sometimes called the COPPER MOSS for that reason. It has been suggested that it is actually linked to the sulphur often associated with copper and possibly betraying chemosynthetic ability. Interesting references to copper mosses include Brooks (New Zeal. Jour. Bot. 9: 674-677, 1972), Persson (Rev. Bryol. et Lichén. 17: 76-78. 1948; Jour. Hattori Bot. Lab. 17: 1-18. 1956), Schatz (Bryol. 58: 113-120. 1955), and Shacklette (U.S. Geol. Surv. Bull. 1198-G, 1967). The moss, not fruiting in North America, is rather small and has lingulate leaves obtuse or rounded at the apex, becoming somewhat bordered because of thickened cell walls with age; the upper cells are small, isodiametric, smooth; the basal cells are laxly rectangular within but noticeably narrower and firmer at the margins.

Whitehead and Brooks (Bryol. 72: 501-507. 1970) showed that aquatic mosses can accumulate uranium.

## GRIMMIACEAE

Plants small to relatively robust, perennial, in dull, mostly dark, rigid tufts or mats, mostly on dry, exposed rocks, rarely on wet rocks or in water. Stems




*Aloina brevirostris.* 336. Habit. 337. Leaf.
*Pterygoneurum ovatum.* 338. Habit. 339. Leaf.
*Scopelophila ligulata.* 340. Habit. 341. Leaves. 342. Upper cells at margin of leaf. 343. Basal marginal cells of leaf.

erect-ascending or prostrate, forked or fasciculately branched, rarely with short, tuft-like branches in a pinnate arrangement. Leaves in many rows, not at all complanate, rarely secund, usually very hygroscopic, rarely crisped when dry, mostly lanceolate and acute, sometimes oblong-ovate and acute to rounded-obtuse, often piliferous; costa single, well developed; upper cells generally small and obscure, sometimes papillose, often bistratose toward the apex or at the margins (sometimes rounded-quadrate and sinuose-nodose or rectangular to linear and very strongly sinuose); lower cells elongate, often somewhat to strongly sinuose-nodose. Setae terminal or lateral, erect or curved, short or elongate; capsules subglobose to cylindric, immersed or exserted, mostly erect and symmetric; annulus sometimes differentiated; operculum mostly rostrate; peristome usually present, single, the teeth 16, long and slender to short and broad, entire or variously cleft or perforate, mostly papillose. Calyptrae generally small, mitrate or cucullate, naked, sometimes campanulate, occasionally plicate.—A family of rock-growing mosses.

Basal leaf cells short, quadrate or oblong, with walls straight or only slightly nodose — 1. *Grimmia*
Basal cells long-linear, with strongly nodose lateral walls — 2. *Rhacomitrium*

## 1. **Grimmia** Hedw.

Plants small or medium-sized, in dull, rigid, typically dark-green, brown, or blackish tufts or mats, sometimes reddish, often hoary. Stems erect or ascending, forked or fasciculately branched. Leaves in many rows, often larger at the stem or branch tips in comose tufts, appressed when dry and rarely crisped or spiraled, usually strongly hygroscopic (on wetting usually suddenly bending backward before becoming erect and finally erect- or wide-spreading), mostly lanceolate and gradually tapered to an acute apex, sometimes oblong or ovate, occasionally blunt or rounded-obtuse, mostly piliferous, generally keeled; margins plane or revolute on 1 or both sides below, mostly entire; costa strong, subpercurrent, frequently entering the base of the awn; upper cells generally small and obscure, rounded-quadrate with walls frequently sinuose or ± nodose, mostly smooth; lower cells mostly elongate-rectangular, frequently ± sinuose-nodose near the costa, frequently pale and subquadrate at the basal margins, sometimes with thickened cross-walls. Perichaetial leaves not much differentiated or sometimes conspicuously enlarged. Setae terminal, very short to elongate, erect to arcuate; capsules immersed to exserted, obovoid to subglobose to oblong-cylindric, mostly symmetric, smooth or ribbed; annulus present or lacking; operculum often rostrate, occasionally falling with the columella; peristome teeth usually present, the teeth flat, broad or lanceolate, sometimes subulate, often blunt or truncate, sometimes perforate or cleft above, ± papillose. Calyptrae small, mitrate or cucullate, naked, not or indistinctly plicate.—Named in honor of J. F. C. Grimm, a physician and botanist of Gotha, Germany. A genus of rock-growing mosses in small, rigid, often blackish or dark-brown tufts or cushions, often confused with *Orthotrichum. Orthotrichum* grows on bark more often than rocks, has a rather large, campanulate-mitrate, plicate, and often hairy calyptra, a fairly well-marked sterile neck, 8 or 16 peristome teeth, and often an inner peristome as well. (The single peristome of *Grimmia* is homologous to the inner peristome of *Orthotrichum,* having originated from a similar primordial cell layer.) In *Orthotrichum,* the texture of the plants is softer, and the walls of leaf cells are never sinuose or nodose-thickened.

1. Leaves plane at the margins; perichaetial leaves similar to upper vegetative leaves; seta excentrically attached to the capsule, curved; capsule bulging at 1 side at base; columella not falling with the operculum ..... 3. *G. plagiopodia*
1. Leaves revolute at the margins; perichaetial leaves noticeably enlarged; seta centrally attached, straight; capsule symmetric; columella falling with the operculum
 2. Leaves narrow and lanceolate, awned; spores 7-12 μ; calyptra cucullate
  3. Plants in small, dense tufts about 1 (rarely 3.5) cm. high; leaves 1.3-2 mm. long, usually entire (except for the awn), smooth at back ..... 1. *G. apocarpa*
  3. Plants in rather large, loose tufts 2-7 cm. high; leaves 1.8-2.5 mm. long, repand-denticulate above, coarsely papillose at back of the costa ..... 1a. *G. apocarpa* var. *stricta*
 2. Plants broadly lanceolate to ovate, muticous or occasionally hyaline-apiculate; spores 9-17 μ; calyptra mitrate
  4. Plants rather small, 1-2(rarely 4) cm. high; leaves broadly lanceolate to ovate-lanceolate, usually entire ..... 2. *G. alpicola*
  4. Plants rather robust, 2-5 cm. high; leaves ovate-lanceolate, repand-denticulate above ..... 2a. *G. alpicola* var. *rivularis*

Geneva Sayre's key to North American species of *Grimmia* (Bryol. 55: 251-260. 1952) is useful in determining sterile material.

1. **Grimmia apocarpa** Hedw.—Plants in small, dense, dark-green or brownish tufts 1-3.5 cm. high. Leaves erect when dry, erect-spreading when moist, 1.3-2 mm. long, ± keeled, lance-acuminate, ending in a rather short, hyaline, denticulate awn but often muticous; margins entire, revolute nearly to the apex; costa not papillose at back,

disappearing in the base of the awn; upper cells ± bistratose toward the apex and at the margins, 5-7 $\mu$, subquadrate, with thick, sinuose walls; basal cells subquadrate and short-rectangular. Autoicous; perichaetial leaves erect, conspicuously enlarged, broadly ovate. Setae about 0.5 mm. long, straight; capsules immersed, symmetric, broadly ellipsoidal, wide-mouthed, about 1 mm. long, smooth; annulus none; columella falling with the operculum which is obliquely short- to long-rostrate from a convex base; stomata few, at extreme base of the urn; peristome teeth lanceolate, red, ± perforate above, finely papillose. Spores 7-12 $\mu$, finely roughened. Calyptrae small, cucullate.—n = 12, 13, 14, 26 (as *Schistidium confertum*).

Conard, How to Know the Mosses, (ed. 2) fig. 136a-f. Darlington, Mosses of Michigan, fig. 63. Grout, Mosses with Hand-lens and Microscope, Pl. 18. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 14, (ed. 2) Pl. 18. Welch, Mosses of Indiana, fig. 84.—**Fig. 344-346.**

On both siliceous and calcareous rocks, especially in dry, exposed places. Nearly cosmopolitan; Alaska to Greenland, south to California, Arizona, New Mexico, Texas, Arkansas, and Georgia.

This widespread, supposedly ubiquitous species has been collected in the Upper Peninsula but not in our area of Michigan. It has been confused and confounded, here and abroad, with *G. alpicola.* The latter, common on the limited rocky habitats of the Straits region, has broader, muticous or minutely hyaline-tipped leaves, mitrate calyptrae, and somewhat larger spores.

1a. Var. **stricta** (Turn.) Hook. & Tayl.—Fairly robust plants in loose, dark-green to red-brown tufts 2-7 cm. high. Leaves erect-spreading and sometimes ± secund, 1.8-2.5 mm. long; margins usually ± notched-denticulate near the apex; costa coarsely papillose at back toward the apex; cells usually coarsely unipapillose on both surfaces—n = 13, 26.

**Fig. 347-349.**

On granitic or calcareous rocks in shady places. Circumpolar; across Canada, south to Arizona and Mexico in the West, Georgia, Tennessee, and the Great Lakes in the East.

MACKINAC CO.—Ozark, McKays Creek.

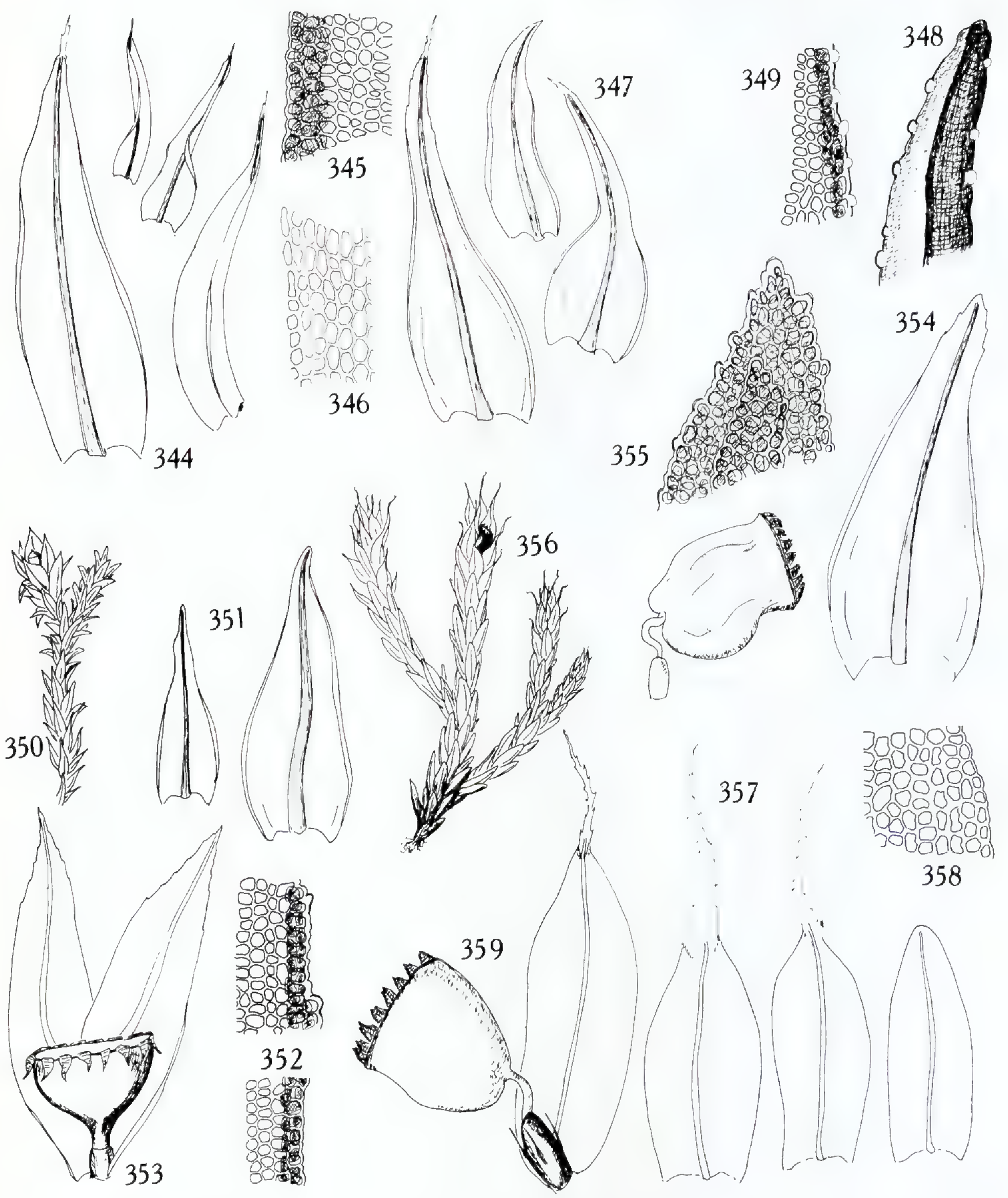
The relatively robust plants in loose, red-brown tufts and the button-like papillae at back of the costa are good characters of this well-marked variety. The leaves are usually shortly piliferous, but not always. The reddish color and larger, looser tufts will distinguish such a form from *G. alpicola* and the narrower leaves from the large tufts of *G. alpicola* var. *rivularis.*

2. **Grimmia alpicola** Hedw.—Plants in dark-green to brown, loose or dense, rigid tufts 1-2, rarely 4 cm. high. Leaves erect when dry, erect-spreading when moist, 1.5-2.5 mm. long, keeled, ovate-lanceolate to ovate, muticous or sometimes hyaline-tipped; margins revolute below, thickened and entire or sometimes ± notched above; costa percurrent or nearly so, smooth or occasionally ± papillose at back above; upper cells 7-9 $\mu$, irregularly subquadrate, thick-walled. Autoicous; perichaetial leaves erect, longer and broader, 3-3.5 mm. long, often hyaline-tipped. Setae 0.8-1 mm. long, straight; capsules immersed, erect and symmetric, wide-mouthed, 1-1.5 mm. long; columella falling with the obliquely short- to long-rostrate operculum; peristome teeth red, ± perforate above, finely papillose. Spores 9-18 $\mu$. Calyptrae small, mitrate.—n = 13, 14.

**Fig. 350-353.**

On both calcareous and acidic rocks, usually in dry, exposed habitats. Circumpolar; across Canada to Alaska, south to California and Texas, widespread in eastern North America, south to Arkansas and North Carolina; Mexico and Ecuador; Australia.

CHEBOYGAN CO.–Biological Station campus, Colonial Point, Mill Creek. EMMET CO.–Pellston Hills, Cross Village, Middle Village, Wilderness State Park, Cecil Bay. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Bush Bay, Epoufette, Ozark, Caffey Corner. PRESQUE ISLE CO.–Grand Lake, Ocqueoc Falls, Rainy River Falls, Posen.




*Grimmia apocarpa*. 344. Leaves. 345. Upper cells of leaf. 346. Inner basal cells of leaf.

*Grimmia apocarpa* var. *stricta*. 347. Leaves. 348. Tip of leaf in profile. 349. Upper cells of leaf at margin.

*Grimmia alpicola*. 350. Habit. 351. Leaves. 352. Upper cells at margin of two leaves. 353. Capsule and perichaetial leaves.

*Grimmia alpicola* var. *rivularis*. 354. Leaf. 355. Cells at leaf tip.

*Grimmia plagiopodia*. 356. Habit. 357. Leaves. 358. Upper cells of leaf. 359. Capsule with perichaetial leaf and dry capsule (at upper right).

Distinguished from *G. apocarpa* by somewhat broader leaves which are bluntly muticous or at most hyaline-apiculate, spores of a greater size range, and mitrate calyptrae, this species grades into the var. *rivularis,* which occupies wet habitats and has broad, notched-denticulate leaves.

2a. Var. **rivularis** (Brid.) Wahl.—Robust, dark-green or brown plants, 2-5 cm. high. Leaves 2-2.5 mm. long, broadly ovate, muticous; margins revolute below, thickened and repand-denticulate above; costa smooth or sometimes ± papillose at back. Autoicous; perichaetial leaves 3.5-4 mm. long. Setae 0.6-0.8 mm. long; capsules 1-1.5 mm. long.—n = 13.

**Fig. 354-355.**

On both calcareous and non-calcareous rocks in stream beds, often in places periodically inundated. Europe and Asia; Greenland; Newfoundland to Pennsylvania and Michigan; Alaska and the Yukon to Arizona, New Mexico, and northern Mexico; Costa Rica.

CHEBOYGAN CO.—Mill Creek.

The habitat (on wet rocks) and broad, muticous leaves with upper margins thickened and repand-denticulate are marks by which this variety may be recognized, at least in its more extreme manifestations.

One might expect the var. **dupretii** (Thér.) Crum in calcareous areas of the state. It is a small form (3-5 mm. high), with leaves only 1-1.3 mm. long and entire and with spores only 9-11 $\mu$ in diameter. The leaves are sometimes, but not always rounded-obtuse.

Sayre (Bryol. 55: 251-259. 1952) made some pertinent remarks on the taxonomy of the genus which "is an extremely variable one and hard and fast lines between species are not always easy to recognize. This factor is the source of much of the synonymy, and especially of the periodic rise and fall of varietal names. Some authors have noted the variations with such care that the typical form of the species is lost sight of. . . . The author accepts a reasonable amount of responsibility if the key proves unworkable, but respectfully reminds the user that this is a genus which contains an *ambigua,* a *varia,* a *decipiens,* a *controversa,* a *revisa* and at least two *anomalas.*" It is my opinion that much of the trouble associated with *Grimmia apocarpa* has resulted from a misunderstanding of the extreme variability of *G. alpicola* and a confusion of the two, with a resulting tendency to segregate unimportant expressions of *G. apocarpa* on the basis of meaningless comparisons with what is actually *G. alpicola*! The history of difficulties presented by *G. alpicola* is summarized by Sayre (Bryol. 49: 3-7. 1946), although she goes farther than I and considers *G. alpicola* a mere variety of *G. apocarpa.*

**Grimmia agassizii** (Sull. & Lesq. *ex* Sull.) Jaeg. & Sauerb. occurs on wet rocks in or near streams or waterfalls in the Upper Peninsula. It is related to *G. alpicola* but has nearly flat, narrow leaves, with nearly parallel sides, and margins plane and not thickened.

3. **Grimmia plagiopodia** Hedw.—Small plants (up to 10 mm. high), in dense, dark-green to brown, somewhat hoary tufts. Leaves crowded and imbricate, scarcely altered when dry, keeled-concave, the lower leaves about 1-1.5 mm. long, oblong-ovate and obtuse to acute and muticous or shortly hyaline-pointed, the upper and peri-

chaetial leaves about 2-2.5 mm. long, broadly oblong or oblong-lanceolate, ending in a long, hyaline, denticulate hair-point which is usually broad at the base; margins erect and entire; costa channeled, subpercurrent or disappearing in the awn; upper cells unistratose, green, 7-12 $\mu$, rounded-quadrate or somewhat longer than broad, with thick, smooth or slightly irregular walls; basal cells pale or hyaline, subquadrate in lower leaves, shortly rectangular in upper leaves, with rather thin but firm, straight walls. Autoicous. Setae shorter than the capsules (about 0.2-0.3 mm. long), slender, curved or curled; capsules immersed, erect or somewhat inclined, nearly hemispheric or broadly oblong, wide-mouthed, bulging on 1 side at the base, about 1-1.5 mm. long; annulus none; operculum low-convex, mammillate to stoutly and bluntly apiculate; exothecial cells large, rather thin-walled; stomata large, at extreme base of the capsule; peristome teeth 16, inserted below the mouth, spreading to reflexed when dry, lanceolate, freely cleft and variously perforate (but not cribrose) at the apex, red-brown, finely papillose. Spores 9-14 $\mu$, smooth. Calyptrae covering only the operculum, mitrate, rostrate, deeply lobed, not plicate, smooth.—n = 26.

Grout, Moss Flora of North America 2: Pl. 5 (below).—**Fig. 356-359.**

Typically on sandstone, sometimes on limestone or concrete of bridge abutments, culverts, or old foundations. Europe; Caucasus; central Asia; Alaska to California and New Mexico and, in the East, rare and scattered from Ontario to the Dakotas, south to Wisconsin, Ohio, and Maryland.

CHEBOYGAN CO.—Mill Creek, Camp Knight (Douglas Lake).

A rare moss resembling *G. apocarpa* because of brownish leaves ending in hyaline hair-points. On closer inspection, however, it proves to be very distinctive owing to the wide-mouthed capsules bulging on one side at base and thus causing the short, curved (or even curled) setae to be excentrically attached. The specific epithet refers to the curved seta.

**Grimmia anodon** BSG, broadly distributed from South Dakota westward, has a narrow annulus and no peristome. It has been found in southern Ontario.

The role of lichens as pioneers on bare rock has no doubt been over-emphasized. Bryophytes such as *Andreaea, Rhacomitrium,* and *Grimmia* may precede lichens. Catherine Keever (Ecol. 38: 422-429. 1957) found that she could easily grow such a primary invader, *Grimmia laevigata,* on crushed granite in petri dishes by regeneration from shoots or plant fragments. Such regenerants grew better on granite if lichens were absent. She found that most herbarium specimens of *Grimmia laevigata* retain viability as long as three years, and some 10-year old specimens will grow. The fact that she was unable to germinate the spores suggests that this (and perhaps other) rock-growing mosses may depend less on spore formation than on regeneration of fragments accidentally broken off during dry periods.

Also occurring in the Upper Peninsula of Michigan are the following:

**Grimmia affinis** Hoppe & Hornsch. *ex* Hornsch. Autoicous; leaves keeled, piliferous, revolute on 1 side below; setae straight, 2.5-3.5 mm. long, longer than the emergent or slightly exserted capsules.

**Grimmia hartmanii** var. **anomala** (Hampe *ex* Schimp.) Mönk. Leaves keeled, the uppermost leaves of occasional branches slenderly acute and hyaline-tipped or short-awned, the others blunt or rounded and muticous, often bearing at their tips large, pale-green or orange-brown, globose brood-bodies; upper cells usually covered by longitudinal cuticular ridges.

**Grimmia pilifera** P.-Beauv. Distinguished from *G. affinis* by dioicous inflorescences; leaf margins revolute on 1 or both sides below; setae only 1 mm. long, not longer than the immersed capsules.

**Grimmia pulvinata** (Hedw.) Sm. *ex* Sm. & Sowerby, a western species found disjunctively in several midwestern localities, grows in small, hoary cushions. The leaves are keeled and long-awned, with margins recurved on one or both sides, and the basal cells have walls rather thin and not or only slightly sinuose. The setae, erect and twisted when dry, are curved when moist; and the capsules, immersed to exserted, are brown and wrinkled-striate when dry.

**Grimmia torquata** Hornsch. *ex* Grev., known from the granitic rocks of Ontario's Lake Superior region, has awned leaves which are twisted, curled, and spirally ranked when dry; the costa is shiny when dry; and red, globose gemmae are produced in chains from the back of the costa on the lower part of leaves terminating each year's growth.

**Grimmia unicolor** Hook. *ex* Grev. Leaves rigidly erect or imbricate when dry, very concave, oblong-ligulate from a broader base, rounded or rounded-obtuse and somewhat cucullate at the apex, muticous; seta 3-4 mm. long, ± flexuose-curved when dry, erect when moist; capsules exserted. It somewhat resembles *G. agassizii* but has a dioicous (rather than autoicous) inflorescence and leaves concave and more or less cucullate at the tip, with cells from the shoulders upward in two or more layers.

## 2. **Rhacomitrium** Brid.

Fairly robust plants in dull, often rigid, extensive mats. Stems creeping or crowded and ascending, freely branched, sometimes with short, tuft-like branches in a pinnate arrangement. Leaves erect or spreading, oblong-lanceolate, acute or acuminate and often piliferous, or rarely blunt or rounded at the apex; costa ending below the apex to excurrent or disappearing in the awn; cells sometimes bistratose toward the apex or at the margins above, incrassate with nodose lateral walls at least in the leaf base, sometimes throughout, linear below, short, pale, and straight-walled at the basal angles, subquadrate or short-rectangular to linear above, smooth or sometimes papillose. Dioicous; perichaetia lateral. Setae elongate, usually straight; capsules erect and symmetric, oblong-ovoid to oblong-cylindric, smooth, wrinkled-striate, or obscurely plicate; annulus well developed; operculum long-rostrate; peristome teeth erect, fused at base and ± completely split to or below the middle into 2 terete or filiform, papillose divisions; pre-peristome present, consisting of a low and inconspicuous, smooth, hyaline membrane adhering to the base of the teeth. Spores spherical. Calyptrae conic-mitrate, often rough (at least at the apex), naked, not plicate.—The name indicates a torn cap, referring rather inappropriately to the mitrate calyptra which is somewhat lobed at base. The nodose lateral walls of the cells, at the base of the leaf and sometimes throughout, are unique features of the genus.

| | |
|---|---|
| Leaves ending in a toothed but not papillose hair-point; cells smooth | 1. *R. heterostichum* |
| Leaves ending in a toothed, papillose hair-point; cells papillose | 2. *R. canescens* |

1. **Rhacomitrium heterostichum** (Hedw.) Brid.—Tufts green to brown, sometimes ± hoary, freely branched. Leaves 2-2.5 mm. long, lanceolate, acuminate, ending in a flat, denticulate, hyaline awn of various lengths, sometimes merely hyaline-tipped or even muticous; margins entire, revolute on 1 or both sides, bistratose above; costa

ending near the apex, not ridged at back; upper cells nodose, smooth (or in section sometimes appearing papillose because of thick walls), 1-1.5:1. Setae twisted when dry, slightly curved or flexuose when moist, 3-8 mm. long; capsules oblong-cylindric, 1.2-2 mm. long, smooth; peristome teeth unequally bifid nearly to the base, brown, rather coarsely papillose. Spores 9-12 $\mu$, papillose. Calyptrae smooth or ± scabrous above.—n = 13, 14; 2n = 28.

Conard, How to Know the Mosses, (ed. 2) fig. 133c-e. Grout, Moss Flora of North America 3: Pl. 22. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 52 (as var. *gracilescens*).

On siliceous rocks. Circumpolar; Alaska to Greenland and south to California, the Great Lakes, and North Carolina. No doubt adventive in our area where it has been collected once on an erratic boulder at Cecil Bay by N. W. Katz, July 25, 1941. (The species occurs naturally in the Lake Superior region of Michigan and Ontario, and it has been collected on Sugar Island in Chippewa County.)

2. **Rhacomitrium canescens** (Hedw.) Brid.—Plants in loose or dense, green, yellowish, or brownish mats. Stems curved-ascending, sparsely fasciculate and often with few to many tuft-like horizontal branches. Leaves erect and often ± curved with flexuose-spreading awns when dry, erect to wide-spreading when moist, 1.5-2.5 mm. long, lanceolate to ovate, slenderly to broadly acuminate, ending in a short to long, hyaline, serrulate, papillose awn; margins unistratose, revolute in the lower 2/3 or more; costa convex at back, subpercurrent or ending somewhat below the apex; cells thick-walled, nodulose, and papillose on both surfaces, 1-2:1 above, linear at the base except for about 4 rows of short, pellucid cells in triangular alar groups. Setae 10-25 mm. long, smooth; capsules 1.2-2.5 mm. long, ovoid-cylindric, irregularly plicate when dry and empty; annulus tardily deciduous; operculum up to 2 mm. long, long-subulate; peristome teeth red-brown, very long, split nearly to the base into 2 filiform, densely papillose divisions. Spores 7-9 $\mu$, smooth or nearly so. Calyptrae papillose above.—n = 12, 13.

Conard, How to Know the Mosses (ed. 2), fig. 62. Grout, Mosses with Hand-lens and Microscope, fig. 62.—**Fig. 360-363.**

A pioneer growing on sand or gravel at shores or in soil among rocks. Circumpolar; Greenland to Alaska and south to California, Colorado, Michigan, and New York.

Found once in our area, near Bryants Bog (at the southwest side of Douglas Lake), Cheboygan Co., on a sand mound next to a ditch in open oak-aspen woods (*D. Caporello*, 1971).

Unmistakable because of flat, toothed, papillose awns and papillose leaf cells. The fo. **ericoides** (Brid.) Mönk. (fig. 364) is evenly pinnate because of an abundance of short, horizontal, tuft-like branchlets. Though distinctive in appearance, this seems to be only an ecological expression. Sand-binding plants seem to have few or no horizontal branchlets; those growing free in more rocky habitats often have many. However, Heinonen (Ann. Bot. Fenn. 8: 142-151. 1971) recognized *R. ericoides* (Hedw.) Brid. at the specific level for the following reasons: In northwestern Europe, it sometimes grows mixed with *R. canescens* and then can be recognized by branching alone. It also has somewhat narrower leaves with a rather longer costa and cells with papillae only about half as high. It tends to be somewhat more oceanic in distribution (though otherwise similar in ecology).

**Rhacomitrium lanuginosum** (Hedw.) Brid., not yet found in Michigan, has leaves ending in long-decurrent, hyaline hairpoints with coarse knot-like teeth at their margins. The leaf cells are linear throughout and (except in the awn) smooth. It is a

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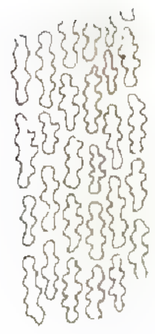


363

361

364

*Rhacomitrium canescens.* 360. Habit. 361. Leaf. 362. Upper cells of leaf. 363. Cells near base of leaf.

*Rhacomitrium canescens.* fo. *ericoides.* 364. Habit.

common species of arctic and alpine tundra, especially among rocks in talus or fell fields; it may occur somewhere in the Lake Superior region.

In Keweenaw and Marquette Counties, we have **R. patens** (Hedw.) Hüb., a distinctive species with the costa conspicuously ridged at back and the upper cells short, not nodulose. The long-standing dispute over placing this species in *Grimmia* or *Rhacomitrium* is neatly resolved by referring it to a monotypic genus, as *Dryptodon patens* (Hedw.) Brid., as proposed recently by Crundwell (Trans. Brit. Bryol. Soc. 6(2): 323-324. 1971).

Other species of the Upper Peninsula, both with muticous leaves, are **R. aciculare** (Hedw.) Brid., with broad, elliptic leaves which are obtuse to rounded and dentate at the apex, and **R. fasciculare** (Hedw.) Brid., with narrowly lanceolate, entire leaves which are slenderly tapered to a narrow, blunt tip.

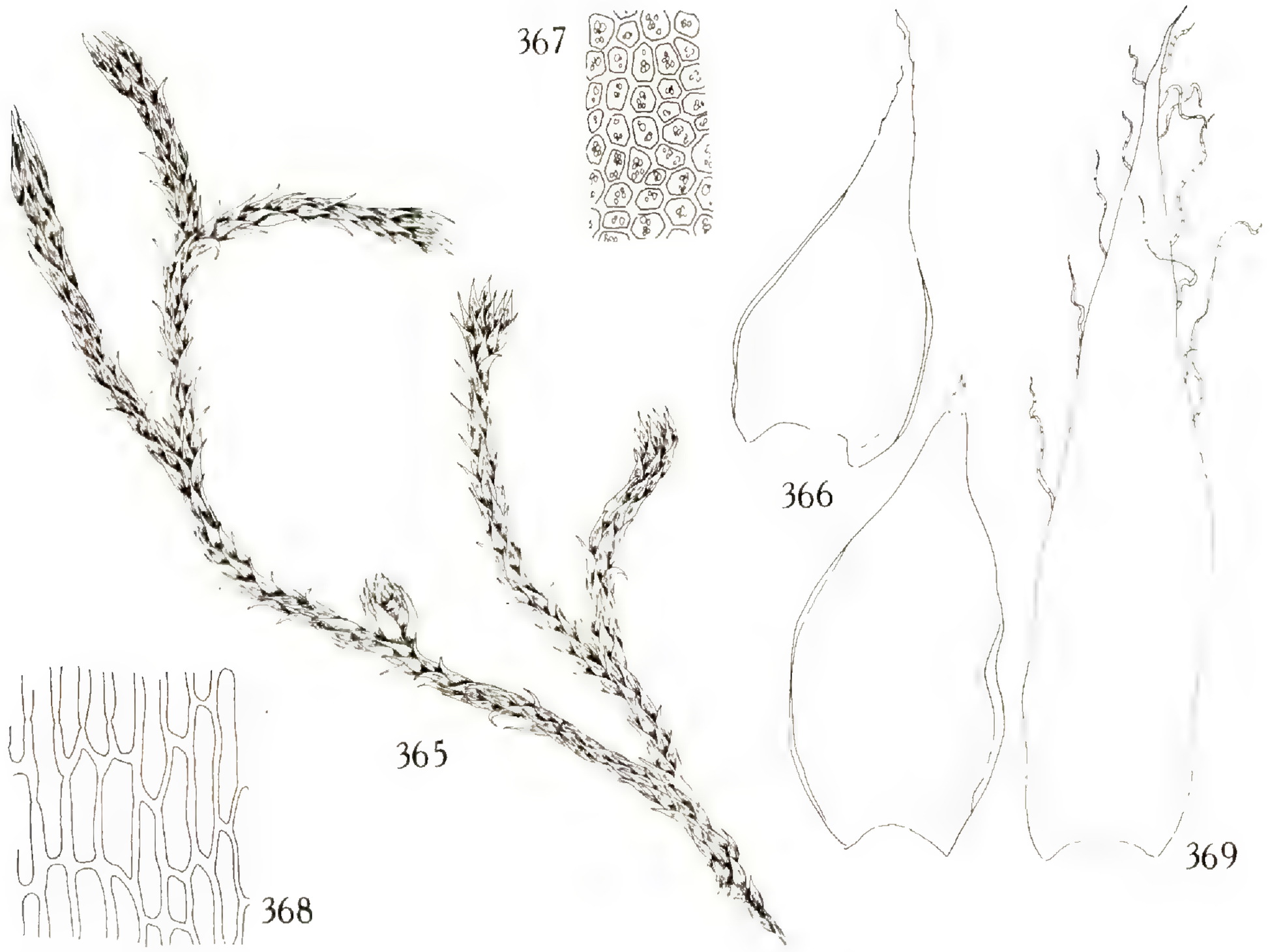
## HEDWIGIACEAE

Fairly robust, rigid plants in loose or dense mats, freely and irregularly to subpinnately branched, crowded and erect-ascending or creeping (or pendent with long, 2-3-pinnate branches), sometimes stoloniferous. Leaves crowded in many rows, appressed when dry, ± spreading when moist, broad and concave, ovate-lanceolate, oblong-ovate, or panduriform, acute, short-acuminate, or piliferous, sometimes plicate, entire (or rarely abruptly toothed at the base of the awn), bordered or unbordered; costa none; cells finely to coarsely pluripapillose on both surfaces, with firm or incrassate walls, subquadrate or oblong to linear above, linear at the middle of the base and variously differentiated at the basal angles. Perichaetia mostly at the ends of main stems or branches; perichaetial leaves ± elongate, erect; paraphyses filiform. Setae short to elongate, erect; capsules immersed to exserted, erect and symmetric, subglobose to ovoid or obovoid, with a short, thick neck; annulus none; operculum low-convex and sometimes umbonate to conic and apiculate or rostrate; stomata in the neck; peristome none (or in *Cleistostoma,* consisting of 16 short teeth deeply inserted on a low membrane). Spores ± large. Calyptrae small and mitrate or large and cucullate.—We have a single genus **Hedwigia** P.-Beauv., consisting of one widespread species. The genus was named for Johannes Hedwig, whose beautiful *Species Muscorum* of 1801 is accepted as the starting point for the nomenclature of mosses (exclusive of *Sphagnum*). Professor of botany at Leipzig, he was a skilled microscopist and the first to understand the sexual function of antheridia and archegonia of mosses. (Goethe, himself a botanist, recorded in his diary, in 1797, a visit to Hedwig's laboratory where he saw elegant preparations and drawings.)

**Hedwigia ciliata** (Hedw.) P.-Beauv.—Coarse and usually rather robust plants in dull mats, green, yellow, or brown and usually grayish or glaucous when dry, often hoary. Stems spreading or curved-ascending, irregularly branched, not stoloniferous. Leaves erect or appressed (or sometimes subsecund) with apices sometimes wide-spreading when dry, spreading when moist, 1.3-2.3 mm. long, sometimes faintly striolate when dry, broadly oblong-ovate, acute to acuminate, nearly always ending in a hyaline tip or a short to long, broad, hyaline acumen; margins revolute in the lower 2/3 or nearly to the hyaline tip or acumen, irregularly spinulose-serrate at the apex, not bordered; upper cells subquadrate to short-oblong or rhombic with ± thickened and irregular walls, with 1-2 simple papillae, becoming somewhat longer and more noticeably porose toward the base; median basal cells linear, smooth, yellow, incrassate, and porose, the basal marginal cells green and quadrate in many rows. Autoicous; perichaetial leaves conspicuously long-ciliate along the upper margins, the cilia hyaline and nodose or toothed. Setae very short; capsules deeply immersed, subhemispheric with a short and inconspicuous neck which is longitudinally wrinkled when dry, wide-mouthed, the rim usually incurved or inrolled when dry, smooth, pale-brown below, red-brown toward the mouth, shiny when dry; peristome none; operculum plano-convex and sometimes umbonate. Spores 20-30 $\mu$, obscurely angled, finely papillose. Calyptra very small, conic-mitrate, hairy.—n = 10, 10+1, 11, 21, 22.

Breen, Mosses of Florida, Pl. 42 (figs. 1-4). Conard, How to Know the Mosses, (ed. 2) fig. 63. Darlington, Mosses of Michigan, fig. 95. Grout, Mosses with Hand-lens and Microscope, figs. 50 & 51 (as *H. albicans*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 30, (ed. 2) Pl. 34. Welch, Mosses of Indiana, fig. 89.—**Fig. 365-369.**

On dry, granitic boulders in the open or in partial shade (in open woods and often in scrubby pastures or at roadsides), rarely on calcareous rocks. Nearly cosmopolitan; widespread in North America.




*Hedwigia ciliata*. 365. Habit. 366. Leaves. 367. Upper cells of leaf. 368. Inner basal cells of leaf. 369. Perichaetial leaves.

CHEBOYGAN CO.–Reeses Bog, Douglas Lake, Colonial Point. EMMET CO.–Pellston Hills, Good Hart, Middle Village, Cross Village, Mackinaw City Hardwoods, Cecil Bay. MACKINAC CO.–Mackinac Island, Ozark.

The plants are rigid and gray when dry but become surprisingly soft, green, and otherwise altered in appearance because of spreading leaves when moist. The length of the hyaline leaf points is highly variable. The specific name refers to long, jointed, hyaline cilia fringing the perichaetial leaves.

Although generally placed near *Orthotrichum* in a group of more or less pleurocarpous families, *Hedwigia* seems to me enough like *Grimmia* to be accommodated in the same family. Since it lacks a peristome one can only guess at its true relationship, whether to the Haplolepideae (as I suspect) or the Diplolepideae.

## FUNARIACEAE

Plants small to medium-sized, light-green or yellowish, gregarious to loosely tufted. Stems erect, simple or forked, radiculose only at base. Leaves small below, larger and more crowded above, usually concave, elliptic to oblong-lanceolate, oblong-ovate, or obovate, usually acute or acuminate; costa single, ending near the apex to excurrent; cells smooth, pale, large, lax and thin-walled, oblong-hexagonal above, sometimes narrower at the margins, rectangular below. Mostly autoicous or sometimes polygamous, rarely synoicous or paroicous; perigonia usually at the ends of 1 or rarely 2 short basal branches, antheridia often in the perichaetia as well; perigonia with short, usually clavate paraphyses; perichaetia terminal, with few, small, filiform

paraphyses, or none. Setae mostly elongate; capsules sometimes immersed, usually long-exserted, erect and symmetric or inclined and asymmetric, usually with a short but distinct neck; annulus often present; stomata usually differentiated, restricted to the neck, consisting of a central slit in a single, rounded guard cell; operculum usually differentiated; peristome lacking, single or double, the teeth 16, lanceolate, usually papillose-striate, the endostome consisting only of segments opposite the teeth. Calyptrae smooth, small and mitrate or large, cucullate, and long-rostrate, often becoming deeply lobed at base.

Capsules erect, symmetric, wide-mouthed (especially when dry and empty), smooth
1. *Physcomitrium*
Capsules inclined, strongly asymmetric, small-mouthed, sulcate 2. *Funaria*

## 1. **Physcomitrium** (Brid.) Fürnr.

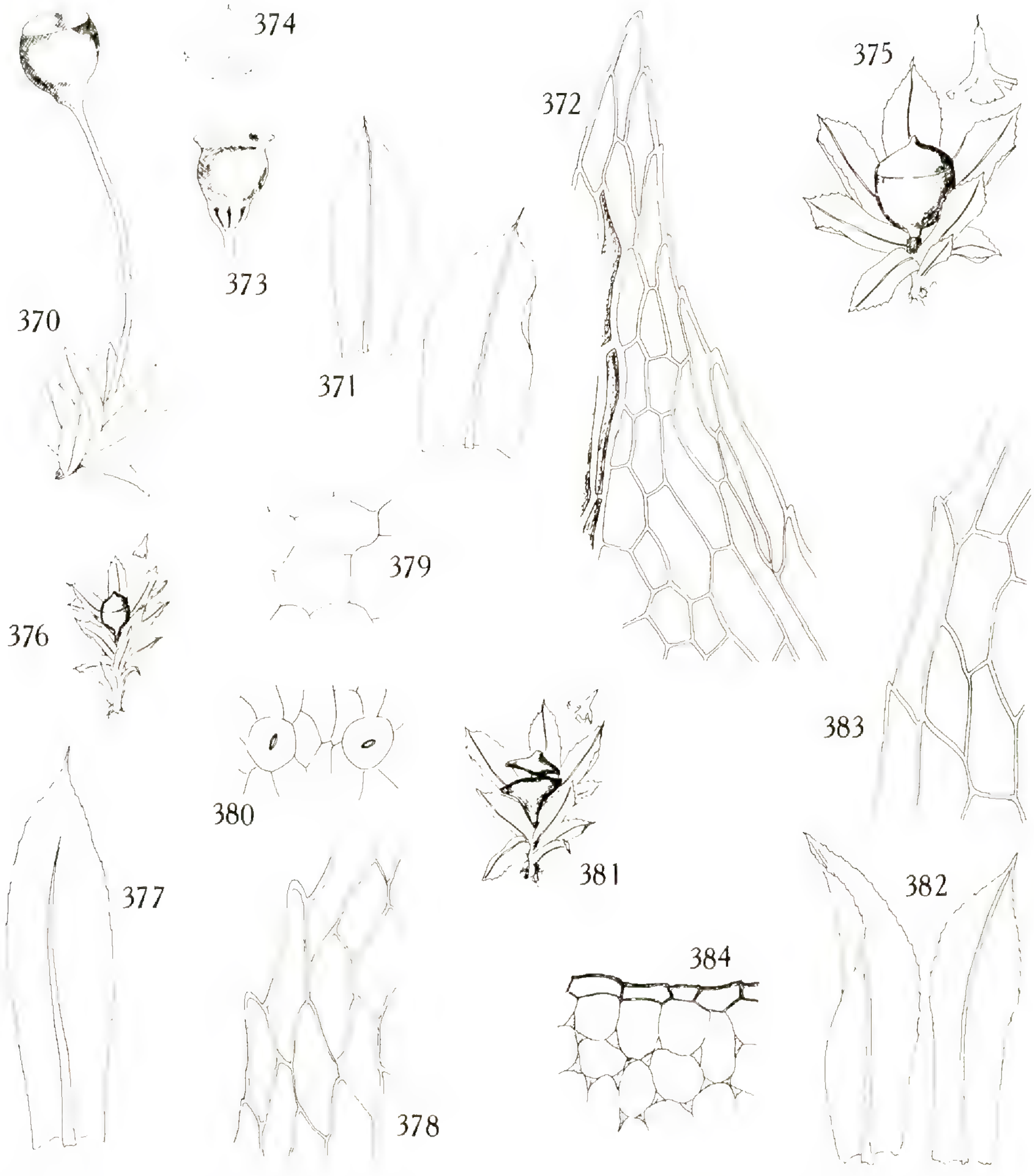
Small, gregarious or loosely tufted, light-green or yellowish plants with simple or forked stems. Leaves erect or erect-spreading, contorted when dry, oblong-lanceolate to oblong-ovate or obovate, bluntly pointed to acute or acuminate; costa ending near the apex to short-excurrent; cells large and lax, oblong-hexagonal above, rectangular below, sometimes ± swollen at the basal angles. Autoicous or occasionally polygamous; perigonial branch basal, with clavate paraphyses, antheridia sometimes in the perichaetium as well; perichaetia with few, small, filiform paraphyses. Setae mostly elongate, erect; capsules mostly exserted, erect and symmetric, hemispheric to urceolate or short-pyriform, wide at the mouth, with a short, usually distinct neck; annulus narrow and persistent or broader and revoluble in fragments; operculum convex, sometimes apiculate or rostellate; peristome none. Calyptra large, long-beaked, inflated at base and deeply split into 3 (or less often 2 or 4) lobes.—The name refers to the inflated calyptra. By the time of maturity, however, the calyptra becomes deeply lobed and loses its bladder-like nature (and the name seems more suitable to *Funaria*, in which the calyptra retains its inflated character).

**Physcomitrium pyriforme** (Hedw.) Hampe—Plants 3-10, rarely 25 mm. high. Leaves 3-5 mm. long, oblong-lanceolate to oblong-ovate, acuminate; margins plane, subentire to bluntly serrulate or serrate above the middle; costa ending near the apex or very rarely short-excurrent; upper cells oblong-hexagonal, paler and narrower at the margins or sometimes ± inflated in 1-2 rows as an indistinct border; lower cells large and oblong, often somewhat inflated at the basal angles. Autoicous or polygamous. Setae 4-14, rarely 30 mm. long; capsules 1-2 mm. long, globose-pyriform, variable when dry and empty but usually constricted below the flaring mouth and at the short neck; annulus narrow, persistent; exothecial cells transversely oblong in 8-17 suboral rows. Spores 24-42, rarely 50 $\mu$, papillose.—n = 9, 26, 27, 36, 52, 54 (and, in experimental material, 18, 24, 69, 71, 72 and 2n = 48+2, 128, 173).

Breen, Mosses of Florida, Pl. 50. Conard, How to Know the Mosses, (ed. 2) fig. 162a-d. Darlington, Mosses of Michigan, fig. 67. Grout, Mosses with Hand-lens and Microscope, fig. 96 (as *P. turbinatum*), Moss Flora of North America 2: Pl. 30 (as *P. turbinatum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 16 & (ed. 2) Pl. 20 (as *P. turbinatum*). Welch, Mosses of Indiana, fig. 95 (as *P. turbinatum*).—**Fig. 370-374.**

On disturbed soil, frequently along roads and in old fields, in spring. Azores, Canary Islands, North Africa, Europe and the Caucasus; widespread in eastern North America; Mexico.

CHEBOYGAN CO.—Colonial Point, Inverness Township, Passino School, Duncan Bay. EMMET CO.—Brutus. PRESQUE ISLE CO.—Posen.




*Physcomitrium pyriforme.* 370. Habit. 371. Leaves. 372. Cells at apex of leaf. 373. Capsule (dry). 374. Calyptra.

*Physcomitrium immersum.* 375. Habit.

*Physcomitrella patens.* 376. Habit. 377. Leaf. 378. Upper cells of leaf. 379. Exothecial cells. 380. Stomata at base of capsule.

*Aphanorrhegma serratum.* 381. Habit. 382. Leaves. 383. Cells of upper part of leaf. 384. Exothecial cells.

An interesting feature is the apical inflorescence in which one can demonstrate the whole developmental sequence from archegonial initial to fertilized egg and young embryo stages. (Antheridia found in basal buds and sometimes also mingled with archegonia in the apical inflorescence are not so easily observed.) This spring weed is sometimes called the TOP MOSS or the URN MOSS, both names referring to the shape of the capsules on drying (contracted below the wide mouth and at the short neck). The specific name means pear-shaped and is not as appropriate as *turbinatum* (or top-shaped), an American synonym formerly in common use.

**Physcomitrium hookeri** Hampe is a prairie species with a large revoluble annulus. (It has not been found in Michigan.)

**Physcomitrium immersum** Sull., (fig. 375; n = 54), not yet found in Michigan, has immersed capsules. The large, beaked, and inflated calyptra, as well as the structural features of urn and operculum, make the generic position immediately clear. It is similar in some ways to two other members of the family which occur in ephemeral situations farther south in Michigan: **Physcomitrella patens** (Hedw.) BSG (fig. 376-380; n = ca. 16) has capsules rupturing irregularly, with exothecial cells very lax and thin-walled. **Aphanorrhegma serratum** (J. Hook. & Wils. *ex* Drumm.) Sull. (fig. 381-384) has operculate capsules with collenchymatous exothecial cells. Both genera have small calyptrae.

The genera of Funariaceae are well marked and easily distinguished, and yet numerous intergeneric hybrids, some actually produced in the laboratory, indicate close cytological and genetic ties. Crosses of *Funaria* with *Physcomitrium* and of *Physcomitrium* with *Physcomitrella* indicate that the absence of peristome or operculum does not necessarily evidence a great degree of evolutionary divergence. Hybrids in the Pottiaceae, between *Weissia* and *Astomum,* and the Ditrichaceae, between *Ditrichum* and *Pleuridium,* further illustrate the close relationship of inoperculate and gymnostomous genera or species to operculate and peristomate ancestors. Hybrids between *Physcomitrium* and *Aphanorrhegma* provide other evidence of relationship within the Funariaceae, and *Funaria-Entosthodon* hybrids de-emphasize the importance of asymmetry of capsules as a generic distinction. References to the literature on supposed hybrids occurring in nature may be found in papers by Timm (Hedwigia 67: 1-44. 1927) and Wettstein (Bibl. Gen. 1: 1-38. 1925). Allen (Bot. Rev. 1: 269-291. 1935) lists numerous hybrids induced between species of Funariaceae. Other information on hybridization is given above, under *Weissia.* Osada (Misc. Bryol. et Lichen. 4: 118. 1967) illustrated a possible hybrid having the capsule of a *Polytrichum* (such as *P. formosum*) but the distinctive leaf lamellae of *Pogonatum alpinum.*

Natural hybrids are unknown in liverworts, although they have been induced between various species of *Sphaerocarpos* (see Allen, Bot. Rev. 1: 269-291. 1935).

Apogamy—the production of sporophytes directly from gametophytic tissue rather than a normal process of fertilization—has been induced in a number of species, for example, in *Physcomitrium coorgense,* an Indian species, by Lal (Phytomorph. 11: 263-269, 1961; also *in* Maheshwari & Swamy, *Plant Tissue and Organ Culture,* pp. 363-383. 1963). A wounded seta may regenerate as a diploid protonema eventually forming leafy shoots which may reproduce sexually or sometimes vegetatively, forming capsules on stalk-like extensions of the shoot. This type of apogamy, which begins as apospory, has been reported in *Phascum cuspidatum, Physcomitrium pyriforme, P. pyriforme* × *Funaria hygrometrica* and the reciprocal, *Desmatodon ucrainicus, D. randii, Grimmia pulvinata* (incompletely), and *Tetraphis pellucida.* Additional data on apogamy are provided by Bauer (Planta 46:604-618. 1956; *Handbuch der Pflanzenphysiologie* 18: 235-256. 1967), Chopra & Rashid (Bryol. 70: 206-208. 1967), Hughes (*A Study of Apogamy,* 1958; New Phytol. 68: 883-900. 1969), Lazarenko (Dokl. Bot. Sci. 134: 177-179. 1961 and 162: 962-964. 1965; Cytol. y Genet. 1965: 158-173. 1965; Dopov. Akad. Nauk Ukraine SSR 11: 1524-1525. 1963 and ser. B, 5: 459-461. 1969), Lazarenko *et al.* (Dopov. Akad. Nauk Ukraine SSR 10: 1381-1384. 1961), Rashid & Chopra (Phytomorph. 19: 170-178. 1969), Springer (Zeitschr. Indukt. Abst. Vererb. 69: 249-262. 1935), and Wettstein (Ber. Deutsch. Bot. Ges. 60: 399-405. 1942). Other species in which apogamy has been observed are *Funaria hygrometrica, Pottia lanceolata, Pottia intermedia* (= *P. truncata* var. *major*), *Amblystegium juratzkanum* (*A. serpens* var. *juratzkanum*), *Leptodictyum riparium,* and *Brachy-*

*thecium campestre.* Viable spores have been produced in some apogamously produced sporophytes (see Lazarenko, 1965). It should be noted that sporophytes have been produced apogamously only on *diploid* gametophytes.

The production of diploid gametophytes by the regeneration of sporophytic tissue (apospory), especially from segments of setae, is easily induced in the laboratory and may also occur in nature, thus accounting for pairs of species differing most notably in sex and chromosome number, as in *Mnium,* for example. It was Pringsheim who first induced apospory in mosses (Monatschr. K. Akad. Wiss. Berlin 1486: 425-429. 1876). Reference should be made to the Marchals' early work on the regeneration of setae (Bull. Acad. Roy. Belg., Sci. 1907: 765-789. 1907; 1909: 1249-1288. 1909; 1911: 750-756. 1911) and Wettstein's work on hybridization and genetics of aposporously produced polyploids (Zeitschr. Indukt. Abst. Vererb. 33: 1-236, 253-257. 1924; Bibl. Genet. no. 10, 1928; pp. 233-272 *in* Verdoorn's *Manual of Bryology,* 1932). LaRue (Papers Mich. Acad. Sci., Arts & Lett. 11: 225-241. 1929) demonstrated regeneration from the setae of 14 species of Michigan mosses. Lowry (Mem. Torrey Bot. Club 20, part 2, pp. 1-42. 1948) provided cytological evidence that some species of *Mnium* could have originated through some such process of regeneration in nature. Apospory probably occurs commonly in nature, providing for polytopic origins of some species, but observations are few indeed: Bower (Science, N.S. 20: 524-536. 1904) reported that Brizi in 1892 had observed regeneration from a capsule of *Funaria* which had been accidentally buried. Other literature on apospory includes Allen (Bot. Rev. 1: 269-296. 1935), Bauer (Ber. Deutsch. Bot. Ges. 70: 424-432. 1957), Bornhagen (Beih. Bot. Centralbl. 46: 407-434. 1930), Lazarenko (Dokl. Bot. Sci. 162: 962-964. 1965; Cytol. y Genet. 1: 15-26. 1967), Lowry (Bryol. 67: 147-149. 1954; Amer. Jour. Bot. 41: 410-414. 1954), Moutschen (Lejeunea 15: 41-50. 1951; Congr. Intern. Bot. Rapp. et Comm., sect. 16: 114-121. 1955), Redfearn & Meyers (Bryol. 52: 197-201. 1949), Stahl (Bot. Zeit. 34: 690. 1876), Schratz (Biol. Zentralbl. 44: 593-623. 1924), Schweitzer (Flora 116: 1-72. 1923, and Stahl (Bot. Zeit. 34: 690. 1876).

The fact that apogamy can be induced by altering culture conditions (see especially Lal, Phytomorph. 11: 263-269. 1961, and Wettstein, Ber. Deutsch. Bot. Ges. 60: 399-405. 1942) and apospory can result from wounding proves that gametophytes and sporophytes have the same genetic potential and are indeed homologous. Hence the antithetic theory of the origin of the sporophyte which assumes a lack of homology loses strength.

Apospory is probably not an important factor in the evolution of mosses but more significant surely than in liverworts where the sporophytes are smaller and simpler and the setae short-lived. Apospory has been induced in a few liverworts by Bornhagen (Biol. Zentralbl. 46: 578-586. 1926), Lang (Ann. Bot. 15: 503-510. 1901), Raudzens & Matzke (Amer. Jour. Bot. 55: 1190-1196. 1968), Matzke & Raudzens (Proc. Nat. Acad. Sci. 59: 752-755. 1968; *in* Gunckel, *Current Topics in Plant Science,* pp. 117-119. 1969), and Schwarzenbach (Arch. Julius Klaus-Stift. Vererb. Soz.-anthr. Rassenhyg. 2: 91-141. 1926).

The special techniques of counting moss chromosomes are given by Snider (Mich. Bot. 9: 67-71. 1970) and Lewis (Trans. Brit. Bryol. Soc. 3(2): 279-284. 1957).

Heald's study of regeneration of gametophytic structures (Bot. Gaz. 26: 169-210. 1898) is worthy of reference.

## 2. **Funaria** Hedw.

Small to medium-sized plants, gregarious or in bright-green or yellowish, loose tufts. Stems usually simple. Leaves small below, becoming larger and more crowded

above, erect, concave, oblong-ovate to obovate, usually acute or acuminate; margins erect, entire or bluntly serrulate above the middle; costa usually ending near the apex, sometimes excurrent; cells large, lax and thin-walled, oblong-hexagonal above, scarcely differentiated at the margins, oblong below. Autoicous; perigonia at the ends of 1 or sometimes 2 short, basal branches; perigonia with clavate paraphyses; perichaetia apparently lacking paraphyses. Setae elongate, capsules inclined to pendulous (rarely suberect), asymmetric, usually curved, broadly pyriform, small-mouthed, mostly plicate or sulcate when dry and empty; annulus large and revoluble or none; operculum convex or rarely conic, its cells in oblique rows; peristome double, the 16 teeth obliquely directed, lance-acuminate, papillose-striate, often strongly trabeculate, frequently appendiculate, particularly above and united in a latticed disc at the apex; segments lanceolate, opposite the teeth and 1/3-2/3 or sometimes nearly as long as the teeth. Calyptra large, cucullate, long-rostrate, inflated at base.—The name refers to the cord-like twisting of the dry seta of *Funaria hygrometrica,* commonly known as the CORD MOSS.

*Entosthodon* differs from *Funaria* only in having erect capsules and a lesser development of the peristome. Bopp (Zeitschr. Bot. 42: 331-352. 1954; Ber. Deutsch. Bot. Ges. 69: 455-468. 1956; Zeitschr. Indukt. Abst. Vererb. 88: 600-607. 1957) has found that phototropic curvature of such capsules is controlled by the calyptra (and in a purely mechanical way, since a dead calyptra has the same effect as a living one). This fact, plus the induction of intergeneric hybrids, presents a challenge to the traditional separation of *Entosthodon* from *Funaria* (which is still a considerable convenience). *Entosthodon* does not occur as far north as Michigan.

**Funaria hygrometrica** Hedw.—Plants 4-10 mm. or more high, tall and laxly foliate throughout or, more often, shorter, nearly naked below and densely foliate and ± bulbiform above. Upper leaves 1-3 mm. long, usually crowded and erect, very concave, oblong-ovate to broadly obovate, acute or apiculate to short-acuminate, entire or somewhat serrulate above; costa subpercurrent to short-excurrent; cells somewhat inflated and oblong-hexagonal (1-2:1) above, longer and oblong below. Setae 12-45, rarely 80 mm. long, slender and flexuose, usually strongly hygroscopic; capsules 2-3 mm. long, broadly pyriform, curved and very asymmetric, horizontal or pendulous, deeply sulcate, strongly oblique at the small mouth (usually bent just below the mouth when dry and empty); annulus revoluble; operculum low-convex; peristome teeth brown and papillose-striate below, pale and papillose above, strongly trabeculate, appendiculate above, joined as a latticed-disc at the tips; segments about 2/3 as long as the teeth, pale-yellow, finely papillose-striate. Spores 11-24 $\mu$, spherical, smooth.—n = 14, 20, 21, 28, 56 (and, experimentally, 12, 28, 30, 60, 240).

Conard, How to Know the Mosses, (ed. 2) fig. 163a-d. Darlington, Mosses of Michigan, fig. 68. Grout, Mosses with Hand-lens and Microscope, fig. 97, Moss Flora of North America 2: Pl. 38. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 27, (ed. 2) Pl. 21. Welch, Mosses of Indiana, fig. 97.—**Fig. 385-389.**

A weed, very common on wet soil in disturbed habitats, often in burned-over places, sometimes on old wood or rock, common in lawns and greenhouses. Cosmopolitan (but largely replaced by var. *calvescens* in tropical latitudes).

CHEBOYGAN CO.—Reeses Bog, Gorge of Carp Creek, Colonial Point, Bryants Bog, Inverness Township, Mill Creek, Cheboygan, Duncan Bay, Weber Lake. EMMET CO.—Brutus, Maple River, Cross Village, Wycamp Creek, Good Hart, Cecil Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island, Nunns Creek, Ozark. PRESQUE ISLE CO.—Ocqueoc River, Mast Point, Lamprey Experiment Station, Evergreen Beach.

The structure and life cycle of *Funaria hygrometrica* are well known to anyone who has had a course in botany. It is called the CORD MOSS, as explained above, and in

*Funaria hygrometrica.* 385. Habit. 386. Leaf. 387. Cells at leaf apex. 388. Peristome as viewed from open end of capsule, diagrammatic. 389. Calyptra.
*Ephemerum crassinervium.* 390. Habit. 391. Leaf.
*Ephemerum cohaerens.* 392. Leaf.
*Ephemerum spinulosum.* 393. Leaf.

Marshall's *Mosses and Lichens* at least, the WATER MEASURING CORD MOSS! The French call it LA CHARBONNIÈRE (a charcoal or coal peddler); and Mrs. Britton aptly referred to it as CINDERELLA as it loves ashes and is often found on wet soil where there has been a camp fire.

The mouth of the capsule is remarkably oblique, and the large annulus is fascinating to watch as it slowly unrolls in a drop of water. The peristome teeth are curved-sigmoid and attached at their tips to a small sieve-like disc. The endostome segments are unusual in being opposite the teeth rather than alternating with them.

Solomon "spake of trees, from the cedar tree that is in Lebanon even unto the hyssop that springeth out of the wall." Stark, in *A Popular History of British Mosses,* stated that a moss, *Entosthodon fascicularis* (Hedw.) C. M., related to *Funaria,* is this *Hyssopus Salamonis,* citing the far-fetched authority of Sir J. E. Smith and the dubious evidence of a specimen in Linnaeus' herbarium collected in the Holy Land by Hasselqvist, who was one of Linnaeus' students. The Moldenkes, in *Plants of the Bible,* made no mention of this collection or of any moss which had been called a hyssop. The word was used a number of times in the Bible, and numerous suggestions have been made as to its identity, the most likely contenders apparently being the caper or the Syrian marjoram.

In England, as summarized by Watson (*Structure and Life History of Bryo-*

*phytes*), *Funaria hygrometrica* is among the first colonists following a fire. It is quickly succeeded by *Ceratodon purpureus* and then by *Polytrichum juniperinum* and *P. piliferum* in association with various Cladonias. The last phase commonly endures for many years. The abundance of *Funaria* in the first phase corresponds to a short period when the substrate has a high pH and a high nutrient content (especially of potash), soon lost by leaching. This information, based in part on a study of a burned-over English heath (Fritsch & Salisbury, New Phytol. 14: 116. 1915) is just as applicable in North America, although Skutch (Ecol. 10(2): 177-189. 1929) found in both Maine and Jamaica that *Marchantia polymorpha* was a common pioneer, followed by *Polytrichum, Peltigera,* and eventually *Pteridium.* Skutch provided a good review of literature on the early stages of plant succession following forest fires (including abundant reference to *Funaria* and *Ceratodon* in early stages). Graff (Bull. Torrey Bot. Club 63: 67-74. 1936) has provided further information on the invasion of burns by *Marchantia* in the American West.

Marshall & Averill (Ecol. 9: 533. 1928) provided data on the alkalinity of burned-over forest soils in northern Idaho where some 125,000 acres of forest were swept by fire in 1926. One year later 58 of 60 scattered tests showed a pH of 7-8, in sharp contrast to the acid reaction normal to forest soils. (Two tests in the acid range could be related to incomplete destruction of duff and humus.) The explanation of such pH values lies in the high potash content of wood ashes. It may be recalled that lye obtained incidental to clearing and burning hardwood forests was important in the economy of early American settlers. Lye was produced by soaking ashes in water. It was used with animal fat, such as lard, in making soap. It was also used in removing the hulls from corn in making hominy. It should be noted, however, that O'Toole and Synnott (Jour. Ecol. 59: 121-125. 1971) reported that *Marchantia polymorpha* and *Funaria hygrometrica* invaded Irish blanket peat after fertilization with calcium carbonate and phosphorus, but response to increased nitrogen and potassium was poor.

At Douglas Lake both *Funaria* and *Marchantia* are uncommon, though no doubt normally successional to fire in wet places.

It may be that the spores of some weeds remain viable for long periods of time and help in that way to explain some widespread distributions. Malta (Acta Univ. Latv. 4: 235-246. 1922) was able to germinate spores of *Funaria hygrometrica* 13 years after their maturity and those of *Ceratodon purpureus* (an even more ubiquitous weed) after 16 years. Meyer (Bryol. 44: 69-75. 1941) reported growing *Funaria hygrometrica* spores which were nine years old, and Hoffman (Bryol. 73: 634-635. 1970) grew some which were 11 years old. Meyer found, however, that spores of the weedy *Physcomitrium turbinatum* (= *P. pyriforme*), which is closely related to *Funaria hygrometrica,* could be grown only from the current and preceding year's crop. Other literature on longevity of spores: Bernstein (Acta Hort. Bot. Univ. Latv. 3: 33-36. 1928); Sussman *in* Ruhland *et al., Handbuch der Pflanzenphysiologie* 15: 1086-1093. 1965).

Schimper (in *Recherche anatomiques et morphologiques sur les mousses.* Strasbourg, 1848) is said to have reported spore germination after 50 years, but Malta (1922) mentioned that Correns cast doubt on the record. Malta (Acta Univ. Latv. 1: 125-129. 1921) reported germinating spores of *Grimmia pulvinata* from a specimen nearly 70 years old. But later (Acta Univ. Latv. 4: 235-246. 1922) he confessed that he had been unable to duplicate the results and therefore considered them based on error. He also observed protonematal growth in a 52-year-old specimen of *Grimmia ovalis* but was not sure whether the growth resulted from spore germination or regeneration.

Spore production may actually be superfluous in some mosses where germination is particularly chancy. Keever (Ecol. 38: 422-429. 1957) could easily grow *Grimmia laevigata,* an invader of bare rock, by regeneration from shoots or fragments but not

from spores, even though spores are produced commonly and abundantly. This suggests that rigid and brittle plants of dry places, likely to be crumbled by accident anyway, may reproduce more efficiently and more certainly by regeneration than by spores.

Hughes (New Phytol. 68: 883-900. 1969) reported that spores of *Grimmia pulvinata* germinate readily to form protonematal growth but no leafy shoots result. Cuttings of setae, however, regenerate by a protonematal growth which sometimes produces leafy shoots. Such diploid shoots can apparently produce capsules vegetatively (by apogamy), but no complete development was observed. Again, it would seem that normal reproduction from spores may be dispensed with in favor of accidental breakage, even though spores are regularly produced in *G. pulvinata,* as in *G. laevigata.*

The ability of mosses to occupy extremely xerophytic habitats or withstand extreme fluctuations in temperature and humidity is well known. Malta (Acta Univ. Latv. 1: 125-129. 1921) reported reviving herbarium specimens, after long periods of storage, as follows: *Anoectangium compactum,* 19 years; *Dicranoweisia cirrata,* 9 years; *Grimmia elatior,* 70 months; *Anomodon longifolius,* 29 months; *Bryum argenteum,* 23 months; *Orthotrichum rupestre,* 22 months; *Grimmia muehlenbeckii,* 18 months; *Rhynchostegiella compacta,* 8 months (growth of brood bodies). Patterson (Bryol. 46: 1-13. 1943), using a respiration method found greater viability in xeric mosses than in hydric and mesic types (after one year of desiccation).

Glime (Bryol. 74: 383-386. 1971) found that a species of *Fontinalis* died after only 55 hours of laboratory desiccation, but two species, *F. novae-angliae* and *F. dalecarlica,* removed from a stream and laid on the bank survived stranding for one year. She reported that *Polytrichum ohioense* lived as long as seven months under laboratory conditions of desiccation.

Xerophytism in bryophytes, including the relation of osmotic pressures and resistance to drought and cold, have been studied by Abel (Oesterr. Akad. Wiss. Wien Math. Naturw. Kl., Abt. 1, 165: 619-707. 1956), Hinshiri & Proctor (New Phytol. 70: 527-538. 1971), Hofleur (Ber. Deutsch. Bot. Ges. 15: 94-107. 1942), Hosokawa & Kubota (Jour. Ecol. 45: 579-591. 1957), Irmscher (Jahrb. Wiss. Bot. 50: 387-449. 1912, reviewed in Bryol. 15: 67-69. 1912), Johnson & Kokila (Bryol. 73: 682-686. 1971), Ochi (Bot. Mag. Tokyo 65: 10-12, 112-118. 1952), and Patterson (Amer. Jour. Bot. 33: 604-611. 1946; Bryol. 67: 390-396. 1964). Ochi (Bull. Soc. Plant Ecol. Sendai 1: 182-187. 1952), on investigating xeromorphism in nine Japanese mosses, concluded that drought resistance is more dependent on osmotic pressure and permeability rather than structural modification. Apparent adaptations for water conservation are listed by Grout (Bryol. 11: 97-100. 1908) and Smith (Univ. Kans. Sci. Bull. 46: 433-474. 1966).

A review of recent research on bryophytes and water relations, edaphic factors, light, radiation, air pollution, and growth form was presented by Miller (Plant Sci. Bull., Dec. 1971: 34-37). An earlier review on water relation was provided by Mägdefrau (Ann. Bryol. 10: 141-150. 1937).

**Funaria flavicans** Mx., a weed in the southern United States, less common northward but extending as far as southern Ontario, differs from *F. hygrometrica* in having scarcely hygroscopic setae, slightly asymmetric capsules which become moderately plicate on drying, and emarginate or bluntly bilobed endostome segments about one-fourth the length of the peristome teeth.

**Funaria americana** Lindb., a rare species of scattered distribution in the East, has smooth capsules, no annulus, segments about three-fourths the length of the peristome teeth, and subentire leaves.

**Pyramidula tetragona** (Brid.) Brid. is a prairie species which may yet be found in Michigan. It is something like *Physcomitrium*, but the seta is short and the eperistomate capsules are enclosed, even at maturity, in a large 4-angled calyptra which allows spore dispersal through a lengthwise tear.

## EPHEMERACEAE

Minute and delicate ephemerals occurring usually as scattered buds on a sparse or abundant protonema. Leaves, few, the lower small, the upper linear-setaceous to lanceolate or ovate-lanceolate, broadly to narrowly acuminate, entire to serrate; costa single and often weak to obsolete or lacking; cells oblong-rhomboidal, mostly lax and transparent, sometimes papillose because of projecting upper ends. Capsules sessile, ovoid or globose, sometimes apiculate, without a neck, indehiscent or opening along a line of weakness near the middle; exothecial cells lax and thin-walled; stomata superficial, with 2 guard cells, or sometimes lacking; columella mostly resorbed at maturity; annulus and peristome none. Spores large, reniform, brown, papillose. Calyptrae small and mitrate or minute and consisting of little more than the unaltered remains of the archegonium.

### **Ephemerum** Hampe, *nom. cons.*

Protonema typically abundant. Leaves not or only slightly shriveled or contorted when dry, linear-setaceous to lanceolate or ovate-lanceolate, acuminate, entire to strongly serrate; costa well developed or rarely lacking; upper median cells oblong-rhomboidal, mostly lax and rather thin-walled, smooth or, more often, papillose because of projecting upper ends. Capsules ovoid, apiculate, indehiscent. Calyptrae small, mitrate, smooth or papillose, naked.–The name refers to the short-lived nature of the plants. Elizabeth G. Britton referred to them appropriately enough as EMERALD DEWDROPS. Although the *Ephemera* have a reputation for rarity, they are not hard to find if one knows what they look like, where they grow, and when to find them. They are pioneers of disturbed soils, able to grow in temporarily available habitats (especially fallow fields in the second year of succession) at times when competition is at a minimum, from fall to spring. Like more weedy and ubiquitous species of such habitats they are favored by a short life cycle. The protonema, though abundant and no doubt physiologically active, is probably not as persistent as generally thought, in view of the short life cycle.

Leaves broadly oblong or oblong-lanceolate, rather abruptly narrowed to a recurved acumen from distinct, asymmetric, irregularly and coarsely serrate shoulders; cells smooth, in oblique rows at the shoulders ..... 2. *E. cohaerens*

Leaves much narrower, more gradually acuminate from the base or from poorly marked shoulders; cells papillose, not in oblique rows ..... 1. *E. crassinervium*

1. **Ephemerum crassinervium** (Schwaegr.) Hampe–Plants green or yellowish. Leaves 0.8-1.5 (rarely 2.5) mm. long, about 0.2 mm. wide, linear-setaceous, scarcely to strongly toothed in the upper 2/3; costa filling the acumen and distinct to the base, papillose at back; upper median cells oblong-rhomboidal, about 4-6:1, usually papillose, often strongly so. Dioicous. Capsules shortly and usually obliquely apiculate; stomata few, scattered throughout the exothecium. Spores 50-75 (rarely 95) × 35-50 $\mu$, coarsely papillose.–n = 27.

Bryan & Anderson, Bryol. 60: 97, figs. 11-19, & 102, fig. 54. Conard, How to Know the Mosses, (ed. 2) fig. 40e. Grout, Mosses with Hand-lens and Microscope, fig. 66.–**Fig. 390-391.**

On moist soil in disturbed places, particularly in old fields, also on river banks etc., in late summer to early spring, depending on latitude. Connecticut to Ontario, Michigan, and Kansas, south to Florida and Louisiana.

EMMET CO.–Brutus. PRESQUE ISLE CO.–Posen.

Easily recognized by the slender, linear-setaceous leaves with the costa nearly filling the acumen and with cells papillose.

2. **Ephemerum cohaerens** (Hedw.) Hampe–Plants green or typically brownish when mature. Largest leaves up to 1.5 mm. long, oblong or oblong-lanceolate, rather abruptly narrowed (sometimes conspicuously so) to a recurved acumen from fairly distinct, asymmetric, irregularly serrate to spinose and ± incised shoulders about 2/3 up the leaf, otherwise serrulate to serrate in the upper 1/2 or more; costa obsolete at base, becoming stronger and thicker above, percurrent or excurrent, ± papillose at back; lower cells large, lax, and oblong or oblong-hexagonal, gradually becoming smaller and rhombic to oblong and arranged in ± diagonal rows in the middle 1/3 (near the base of the acumen), smooth or sometimes ± papillose. Polyoicous (dioicous or autoicous). Stomata distributed over the entire capsule. Spores rather finely to coarsely papillose, 45-54 × 60-95 $\mu$. Calyptrae usually smooth.–n = 27.

Bryan & Anderson, Bryol. 60: 99, figs. 28-35 & 102, fig. 56. Conard, How to Know the Mosses, (ed. 2) fig. 40d. Darlington, Mosses of Michigan, fig. 65. Grout, Mosses with Hand-lens and Microscope, fig. 65.–**Fig. 392.**

On bare soil in wet places, along streams and in pastures, marshes, or meadows, both spring and fall (and locally, at least, also in mid-summer). Europe; southern Canada, south to Florida, west to Iowa and Texas. Not yet found in our area, this species has been collected in nearby Alpena and Montmorency Counties and in numerous more southerly counties.

The asymmetric leaves with irregularly toothed or jagged shoulders and obliquely arranged cells are unmistakable. The only other species known from Michigan (somewhat resembling *E. crassinervium*) is **E. spinulosum** Bruch & Schimp. *ex* Schimp. (fig. 393), which has linear-lanceolate leaves, spinose-serrate because of spreading or recurved teeth; the costa is percurrent but does not fill the apex; and the cells are papillose. (The chromosome number of *E. spinulosum* is n = 27.)

The photomicrographs published by Bryan and Anderson (Bryol. 60: 67-102. 1957) provide the easiest means of identifying North American species.

## SPLACHNACEAE

Plants small to fairly robust, gregarious or, more often, loosely to densely caespitose, usually ± tomentose, mostly growing on bones, dung or other decaying organic matter. Stems erect, forked, often bearing minute, claviform-cylindric filaments in axils of upper leaves. Leaves soft, mostly broad, ovate-lanceolate to oblong or spatulate, entire to dentate or rarely laciniate-toothed, sometimes bordered; costa single, strong, generally ending below the apex; cells smooth, lax and pale, relatively large, oblong or oblong-hexagonal above, the lower cells oblong, not differentiated at the angles. Perichaetial leaves scarcely differentiated; perigonia often large and conspicuous, with filiform paraphyses. Setae mostly elongate, erect; capsules mostly exserted, erect and symmetric, usually with a conspicuously differentiated neck (the hypophysis), sometimes merely elongate, often swollen or expanded; annulus mostly lacking; operculum convex to conic (very rarely undifferentiated); stomata abundant,

with 2 guard cells; peristome nearly always present, single, the 16 teeth various in form, frequently in groups of 2 or 4 and ofter ± fused, entire or rarely deeply forked. Calyptra mitrate or rarely cucullate, naked or sometimes hairy.

## **Splachnum** Hedw.

Plants in soft, loose, pale- or yellow-green, somewhat shiny tufts, radiculose below. Stems loosely foliate, simple or forked. Leaves large, usually more crowded toward the stem tips, erect or erect-spreading, soft, somewhat flexuose-contorted when dry, broadly obovate, obtuse to acute or serrate above; costa ending in or below the apex; cells large, lax, thin-walled, pale, smooth, oblong-hexagonal above, rectangular below. Autoicous or dioicous; perichaetia scarcely differentiated; perigonia large and cupulate, the bracts with long, narrow, spreading acumina. Setae smooth, slender and mostly elongate, sometimes very long because of continued growth after maturity of spores; capsules erect, consisting of a small, subcylindric, brownish, firm-walled urn and a broader, more delicate, globose, pyriform, or turbinate hypophysis strikingly different from the urn in color and texture and generally wrinkled on drying, usually continuing growth after spore maturation and sometimes becoming greatly expanded and skirt- or umbrella-like; annulus none; operculum convex or hemispheric, often somewhat umbonate, sometimes stoutly and bluntly apiculate; exothecial cells irregularly hexagonal, ± incrassate, often somewhat collenchymatous, smaller and usually ± oblate in numerous suboral rows; cells of the hypophysis, large, lax, thin-walled, hexagonal; stomata in the upper part of the hypophysis; columella shortly exserted; peristome teeth 16, inserted at or below the mouth, sometimes in pairs, reflexed when dry, inflexed when moist, lanceolate, densely and minutely papillose on the outer surface, derived from 3 peristomial layers of cells and chambered. Spores spherical or ellipsoidal, small, smooth. Calyptrae small, conic-mitrate, often becoming split on 1 side, not constricted at the base, smooth, naked.—*Splachnum* was a name used by Dioscorides presumably for the lichen *Lobaria pulmonaria,* which has a lung-like appearance roughly similar to the wrinkled hypophysis of some species of *Splachnum.* In spite of a predilection for dung as a substrate, the species of *Splachnum* are among the most elegant and colorful of all mosses.

**Splachnum ampullaceum** Hedw.—Plants 1-4 cm. high. Leaves 3.5-4 mm. long, long-lanceolate to narrowly oblong-ovate, slenderly acuminate; margins deeply spinose-dentate in the upper half or less; costa disappearing in the acumen somewhat below the apex. Dioicous (male and female plants invariably mixed). Setae 15-65 mm. long, slender, flexuose, red or red-brown; urn 1-1.2 mm. long, yellow-brown; hypophysis much broader, 2-6 mm. long, top-shaped, rugose, pinkish to pale-purple, becoming dark-brown with age; operculum hemispheric, blunt; peristome teeth inserted near the mouth, united in pairs, pale-brown or orange-brown. Spores 7-9.5 $\mu$, subspherical (slightly longer than wide), smooth.—n = 8, 9, 10 (and, in experimental material, n = 8, 16, 32).

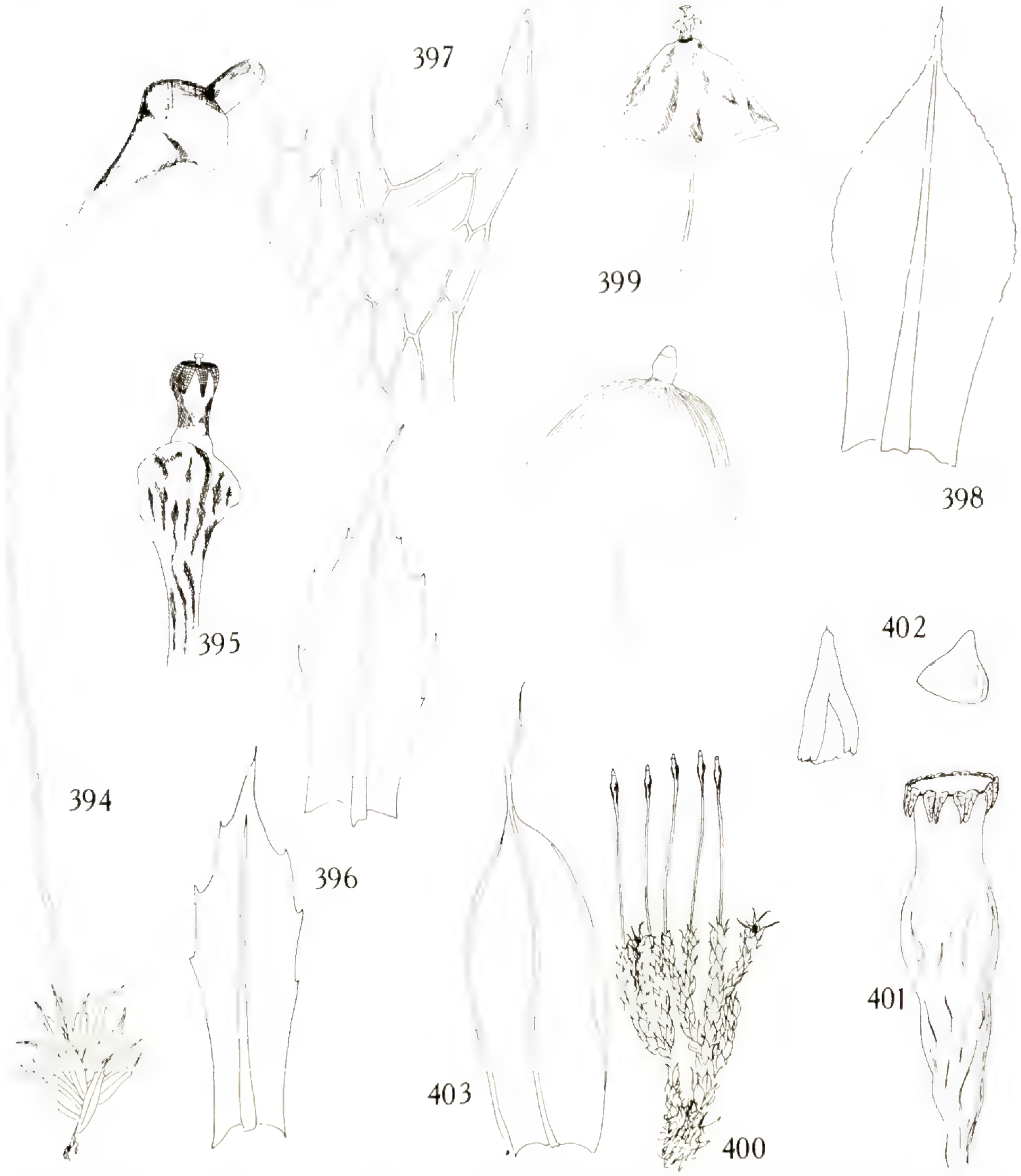
Darlington, Mosses of Michigan, fig. 70. Grout, Mosses with Hand-lens and Microscope, fig. 94. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 52.—**Fig. 394-397.**

On old dung of cows (or occasionally other herbivores, such as moose, deer, or horses) in peat bogs and bog forests. Circumpolar; British ,Columbia and Alberta, Nova Scotia to New England, West Virginia, and Michigan.

CHEBOYGAN CO.—Little Lake 16. EMMET CO.—Stutsmanville Bog. PRESQUE ISLE CO.—Hammond Bay.

The large teeth on the margins of the leaves, often consisting of several cells, distinguish *S. ampullaceum* from other members of the genus and, indeed, the entire family.

**Splachnum rubrum** Hedw. (fig. 398-399), with a red, skirt-like hypophysis, occurs on moose dung on Isle Royale in Keweenaw County. **S. luteum** Hedw. has a lovely yellow skirt. Of them, Mrs. Britton (The Observer 7: 637-645. 1896) said, "Fairy parasols, red and yellow, that is what they seem to be, not ordinary umbrellas meant to be taken out in the rain, but bright, gay, silky, showy things, only used by Titania when in holiday attire. But the books will tell you that they are called 'Umbrella Mosses.'" (She failed to comment on the name PETTICOAT MOSS.)




*Splachnum ampullaceum.* 394. Habit. 395. Capsule (dry). 396. Leaves. 397. Upper cells of leaf at margin.

*Splachnum rubrum.* 398. Leaf. 399. Capsule, moist and dry.

*Tetraplodon mnioides.* 400. Habit. 401. Dry capsule. 402. Operculum and calyptra. 403. Leaf.

The odd habitats of *Splachnum* and related genera have excited considerable interest. Kerner von Marilaun's account is pleasant:

"In mountain districts, where cattle continually pass to and from the meadows and alps, one notices on their halting grounds, and along their tracks, moss of a conspicuous green colour growing on circumscribed spots. On closer examination we find that we have here an example of the remarkable group of the *Splachnaceae,* and that it has selected the cow-dung to be its nutrient substratum. Each growth of emerald green, *Splachnum ampullaceum,* is strictly limited to the area of a lump of dung . . . hundreds of little green stems, thickly clothed with leaves, emerge, and the spore cases, which resemble tiny antique jars, and are amongst the prettiest exhibited by the world of mosses, become visible as well."

He further reported that *Splachnum rubrum* and *S. luteum* grow only on reindeer dung in arctic latitudes of Europe. In North America, they are found on moose dung. He recorded that *Tayloria serrata* is seen only near cow chalets on decomposing human feces. I have not observed that species in the field, but I have found *Haplodon wormskjolfii* on what seemed to be human dung near Eskimo dwellings in Alaska.

*Tayloria rudolphiana,* in Europe, apparently grows most often on mossy trunks and branches of *Fagus silvatica* and *Acer pseudo-platanus,* where it is associated with the excrements of birds of prey.

Hooker and Taylor, in the *Muscologia Britannica* reported that they once saw *Tetraplodon angustatus,* which normally grows on the dung of carnivores, on the foot of an old stocking, and the same species was found by a friend of their covering the half decayed hat of a traveler who had perished on the mountain of St. Bernard in Switzerland.

In northernmost Alaska, on Point Barrow, where Eskimos have slaughtered whales since time immemorial, are vast swards of *Splachnum vasculosum,* which also grows on dung.

The genus offers a number of adaptive features of interest. The seta continues growth even after the maturation of spores, suggesting an evolutionary attempt, similar to that of *Anthoceros,* to develop a long-lived and independent sporophyte. Coupled with this is a high degree of sterilization of sporophytic tissue, a trend continued so successfully by higher plants. The greatly expanded hypophysis has numerous stomata and a spongy internal structure similar to a mesophyll. The sporophyte is, in fact, a functional approach to a sporophyll. (The sexual dimorphism of some other mosses is associated with chromosomal dimorphism and sometimes spore size differences and further illustrates an evolutionary experiment with sporophyll development which was carried to a more successful conclusion by vascular plants.)

Vaizey (Ann. Bot. 5: 1-10. 1890) came to the conclusion that the highest development of the moss sporophyte is reached in *Splachnum* in which the hypophysis serves the same functions as the leaves of higher plants. He even went so far as to suggest homology. Further speculations on such homologies (or analogies) are presented by Crum (Bryol. 69: 205-207. 1966).

*Splachnum* has many adaptations for the dispersal of spores by insects (and presumably such as also visit fresh dung for breeding purposes). The hypophysis may be spherical and wrinkled when dry or enlarged and expanded, in both cases brightly colored like a flower and, one would think, attractive to insects and providing a landing space for them (although insects are not sensitive to the same spectrum of color as we are). The dung on which the plants grow is thoroughly humified and, to a man at least, smells only like fresh earth, but the hypophysis emits a faint, unpleasant odor apparently through the stomata; this is especially noticeable under conditions of humidity. I have noticed sour or musty odors in *Splachnum* and *Tetraplodon*; the smell is obvious when plants are taken from the dampness of a vasculum at the end of

a collecting day, but it is difficult to demonstrate even moments afterward. A final feature conducive to insect dispersal is that the spores adhere in clumps and are not likely to be blown free in the air. The columella is thickened at the apex and acts as a plug when the capsule is moist, but it is exposed, together with the mass of spores, by shrinkage of the dry capsule.

Information on dispersal of spores of Splachnaceae is provided by Bequaert (Bryol. 24: 1-4. 1921), Bryhn (Biol. Centralbl. 17: 48-55. 1897), Erlanson (Bryol. 33: 13-14. 1930), Walsh (Trans. Brit. Bryol. Soc. 1(5): 487. 1951), and Wettstein (Österr. Bot. Zeit. 70: 65-77. 1921).

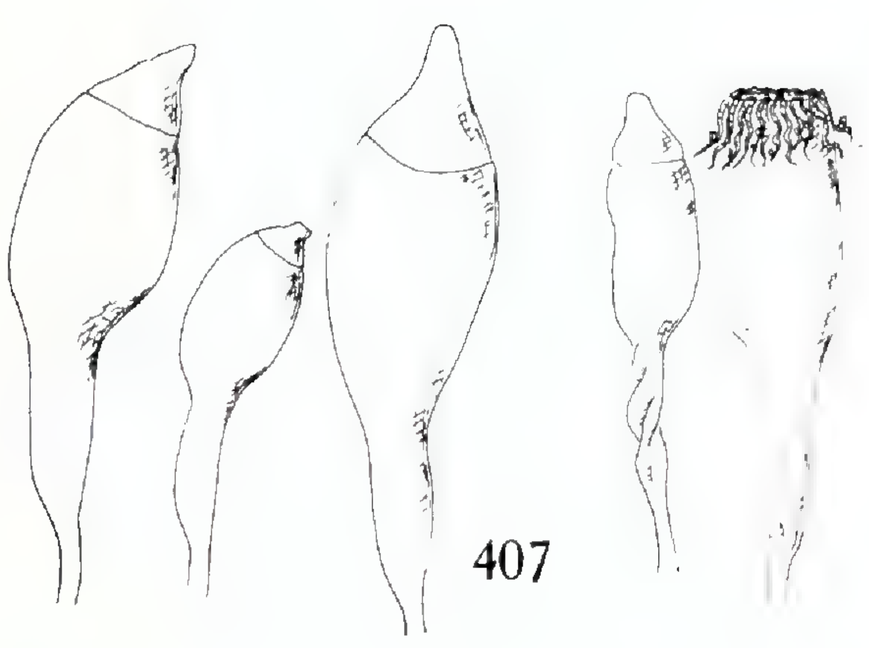
Steere (Amer. Nat. 92: 5-20. 1958) suggested an interesting correlation of the odors emitted by capsules of various Splachnaceae to the evolution of the family: "So far as I know, these are the only mosses whose capsules have specific odors. The capsule of *Tetraplodon* has the strong sharp odor of an acetic ester. *Splachnum ovatum* smells strongly of lactic acid, and *S. luteum* is reported to have the odor of a butyl compound. . . . A correlation that may have some significance is that the more highly modified and specialized species, morphologically, also have the odor of the more complex organic compound. The biochemical evolution in *Splachnum* . . . would seem to promise a fertile field for investigation."

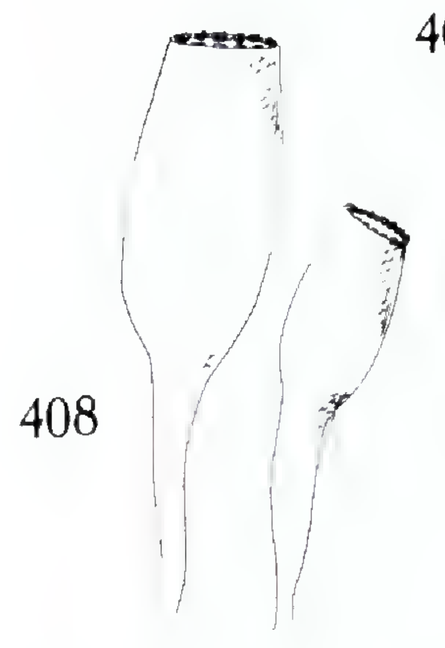
We have, in the Upper Peninsula, two species of *Tetraplodon* which grow on the dung of carnivores (such as wolf), bones, or owl pellets. The hypophysis is elongate-pyriform and narrower than the spore-case; the 16 teeth of the peristome are at first more or less joined in 4's, later in 2's. **Tetraplodon angustatus** (Hedw.) BSG is small, with leaves oblong-lanceolate, and gradually subulate, irregularly serrate, and its capsules are brown and not or slightly exserted; the hypophysis is also brown. **Tetraplodon mnioides** (Hedw.) BSG (fig. 400-403) is more robust and has oblong-ovate, rather abruptly subulate, entire leaves and capsules which are red (becoming dark-red or blackish) and long-exserted; the hypophysis is usually darker than the capsule. Chromosome numbers reported for *T. mnioides* are n = 11, 19.

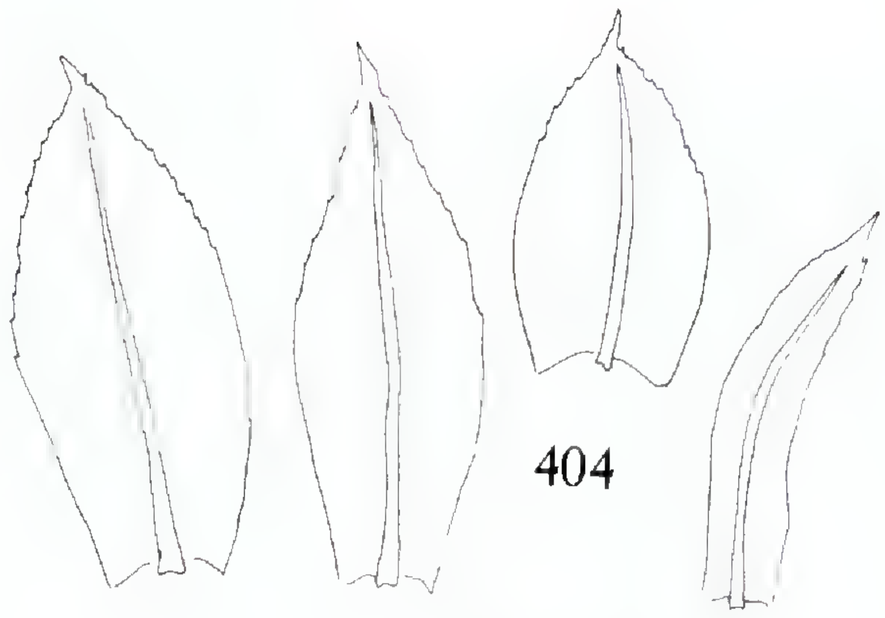
Several other species of Splachnaceae might conceivably occur in the northern reaches of the Great Lakes area, including **Splachnum sphaericum** Hedw. (also known as *S. ovatum* Hedw.), **Tayloria acuminata** Hornsch. (fig. 404-409), **T. lingulata** (Dicks.) Lindb., **T. serrata** (Hedw.) BSG (fig. 414-418), and **T. splachnoides** (Schleich. *ex* Schwaegr.) Hook. (fig. 410-413). *Splachnum sphaericum* has a purplish to blackish hypophysis only slightly broader than the urn (and resembles in capsule shape a *Tetraplodon*). It occurs on moose dung. *Tayloria lingulata* grows scattered on wet soil especially at the margins of dried-up pools no doubt enriched by dung of wading birds. It takes the name from its tongue-shaped leaves which are broadly rounded at the apex.

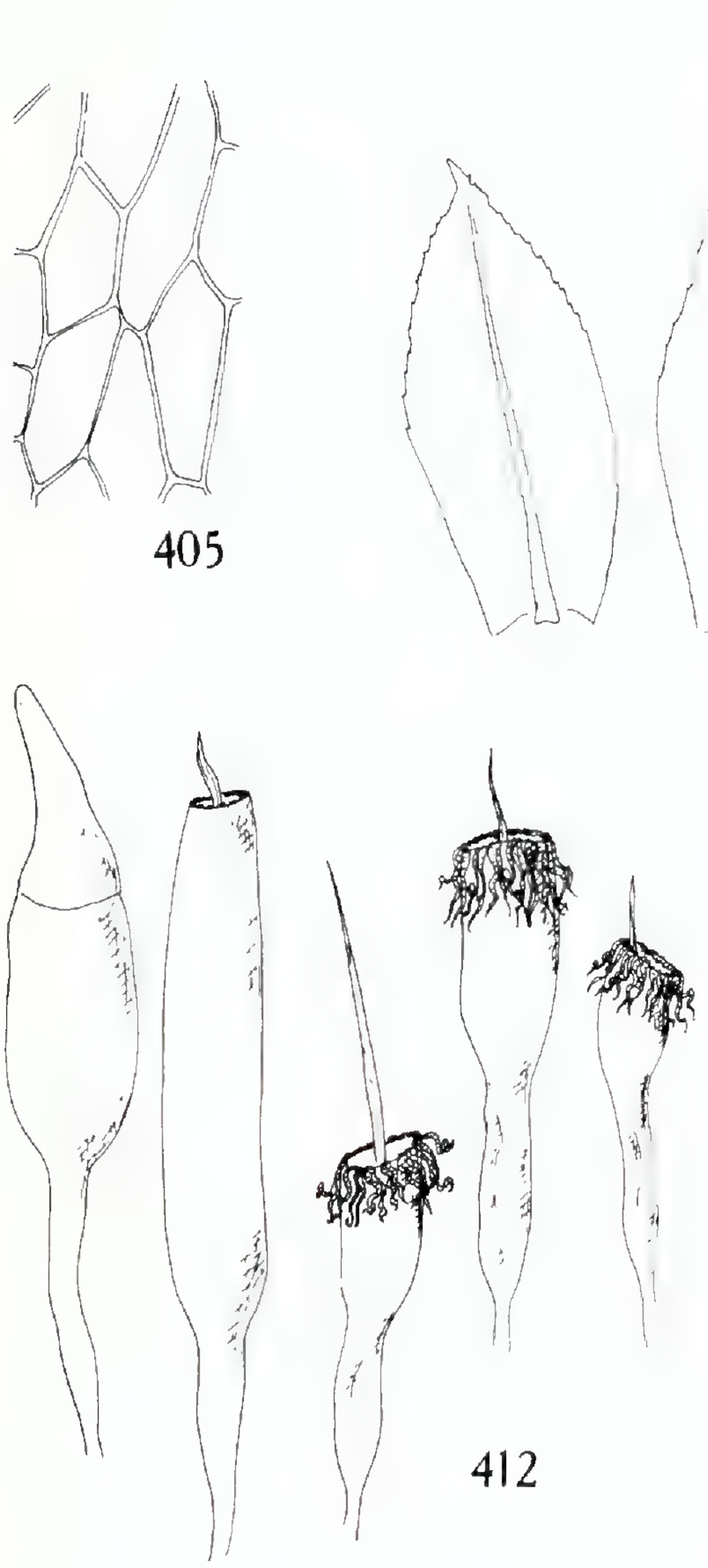
## SCHISTOSTEGACEAE

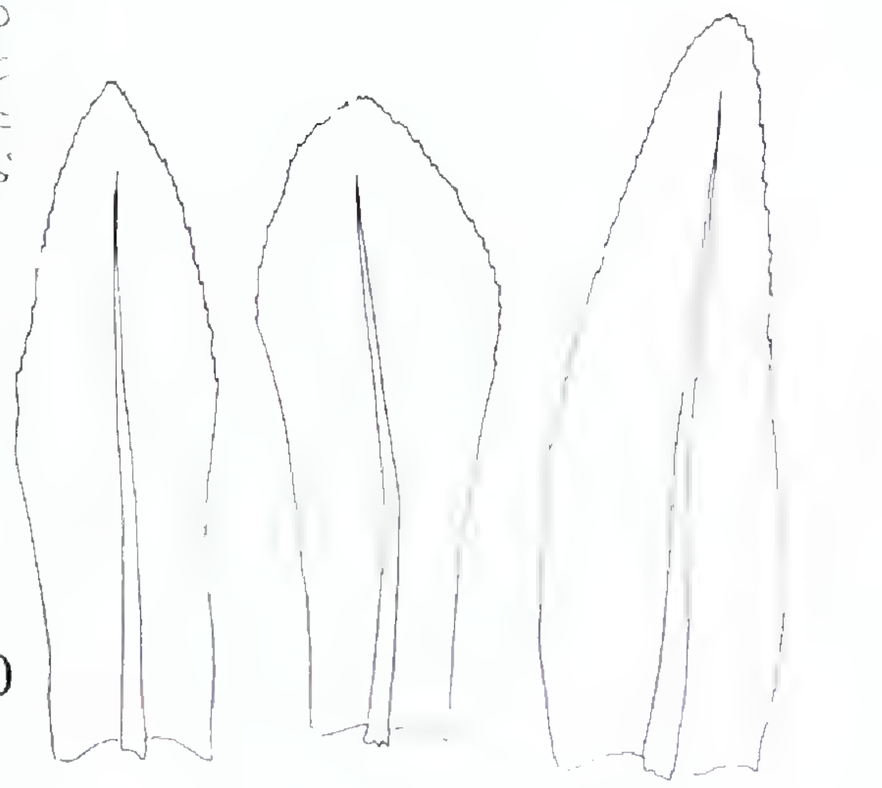
A family of a single genus, **Schistostega** Mohr, and one species: **Schistostega pennata** (Hedw.) Web. & Mohr. LUMINOUS MOSS. CAVE MOSS. GOBLIN GOLD.– Plants small and delicate, 4-7 mm. high, gregarious or loosely tufted, radiculose only at the base, growing from a persistent protonema which is luminous because of light reflected from vesiculose cells in conidia-like chains. Plants dimorphous: Sterile stems erect-flexuose, naked below, pinnately foliate and frondiform above; leaves 0.7-1.2 mm. long, distichous-complanate, little altered when dry, oblong or oblong-lanceolate, slightly asymmetric, acute, confluent at base because of decurrencies, ecostate; margins plane, entire (or sinuolate), indistinctly bordered); cells laxly oblong-rhomboidal, thin-walled, smooth, pellucid, 16-20 $\mu$ wide and about 5 : 1 above, somewhat narrower








*Tayloria acuminata*. 404. Leaves. 405. Leaf cells. 406. Axillary club hairs. 407. Capsules, moist (at left) and dry. 408. Two moist capsules showing inrolled peristome. 409. Exothecial cells.

*Tayloria splachnoides*. 410. Leaves. 411. Leaf cells. 412. Capsules, wet and dry. 413. Exothecial cells.

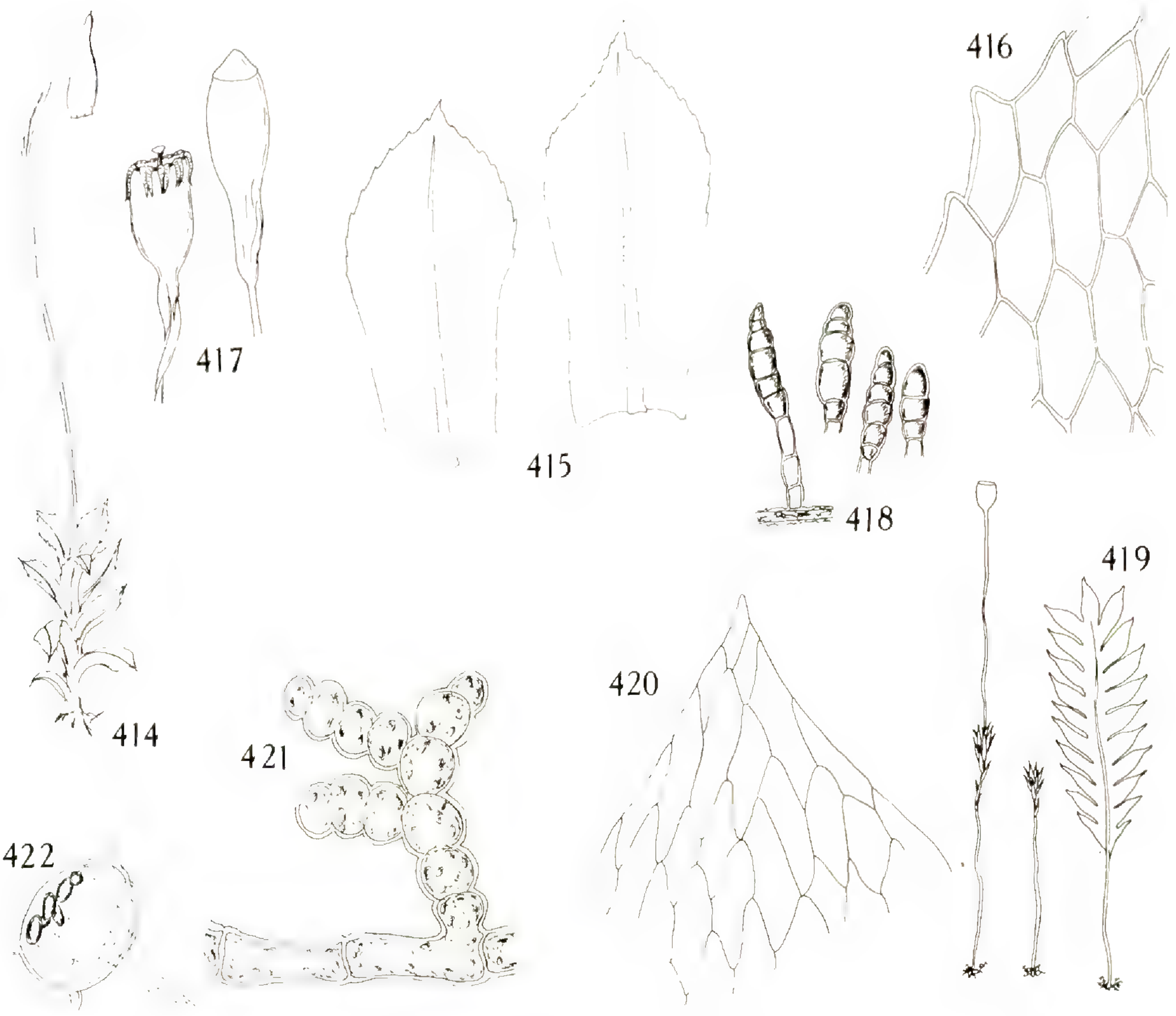
in a marginal row, rectangular below. Fertile plants (both male and female) mixed with the more conspicuous sterile plants, more slender, with smaller, erect-spreading leaves inserted all around the stem in a crowded tuft at its tip. Dioicous. Setae 2-5 mm. long, pale, slender, flexuose, smooth; capsules erect and symmetric, very small (0.4-0.5 mm. high), subglobose or ovoid (*i.e.*, wide at the base and small at the mouth), smooth; annulus and peristome none; exothecial cells irregularly hexagonal, thickened at the corners, with 1-2 rows at the mouth darker, smaller, and subquadrate, often resembling

a persistent annulus; stomata none (or few and difficult to observe); operculum plano-convex. Spores spherical, 10-13 $\mu$. smooth. Calyptra very small, conic-mitrate.—n = 11, 14.

Conard, How to Know the Mosses, (ed. 2) fig. 31. Darlington, Mosses of Michigan, fig. 71. Grout, Mosses with Hand-lens and Microscope, fig. 93 (as *S. osmundacea*). Excellent photographs, including pictures of the protonema, are provided by Johnson (Bryol. 29: 17. 1926), Iwatsuki & Inoue (Dare Nimo Wakaru Koke No Subete, p. 60, 1971), Kobayabi & Watari (Jour. Jap. Bot. 11: 433-437. 1935), and Kanda (Hikobia 6: 60-75. 1972).—**Fig. 419-422.**

A rare species not likely to be found in the limey habitats of the Straits Counties but occurring in Scotts Cave west of Au Train in Alger County. It is characteristically found in caves associated with sandstone rocks but also occurs in other dark recesses, under old barns or in cavities under upturned roots of trees, for example. Europe; Japan; British Columbia to Washington and Alberta; rare and scattered from Wisconsin to Newfoundland and south to New York and Rhode Island.

The genus is defined by its dimorphous growth habit and luminous protonema which makes possible its growth in dark habitats. The epithet *pennata,* meaning feathery, is aptly descriptive, as was an epithet formerly in use, *osmundacea,* referring to the fern-like appearance of sterile plants. The generic name, meaning split operculum, resulted from an erroneous observation that the operculum becomes




*Tayloria serrata.* 414. Habit. 415. Leaves. 416. Upper cells of leaf. 417. Capsule, wet and dry. 418. Brood-bodies on radicles.

*Schistostega pennata.* 419. Habit of sterile and fruiting plants. 420. Cells at leaf tip. 421. Portion of protonema in diffuse light. 422. Protonematal cell lighted from one side.

radially split into tooth-like segments. William Wilson, unable to find radiating fissures on examination of living material, remarked that "the operculum is the very thickest and the most sturdy that I ever met with . . . filling the mouth exactly like a bung, composed strictly of cells of an hexagonal form pervading the thickness of the lid, and not infrequently disposed so as to stand in rows from the centre to the circumference, so that when any part of the lid is obliquely placed, with respect to the eye, the partitions of the cells, in perspective, represent dark lines resembling radii" (in Smith's *English Flora,* vol. 5, part 1, p. 16. 1844).

The luminous appearance of the moss is caused by reflection from lens-like cells of the protonema. The account given by Kerner von Marilaun* (in his *Pflanzenleben*, translated by F. W. Oliver as *The Natural History of Plants*) has appeal: "On looking into the interior of the cave, the background appears quite dark, and an ill-defined twilight only appears to fall from the centre on to the side walls; but on the level floor of the cave innumerable golden-green points of light sparkle and gleam, so that it might be imagined that small emeralds had been scattered over the ground. If we reach curiously into the depth of the grotto to snatch a specimen of the shining objects, and examine the prize in our hand under a bright light, we can scarcely believe our eyes, for there is nothing else but dull lustreless earth and damp, mouldering bits of stone of yellowish-grey colour! Only on looking closer will it be noticed that the soil and stones are studded and spun over with dull green dots and delicate threads, and that, moreover, there appears a delicate filigree of tiny moss-plants, resembling a small arched feather stuck in the ground. This phenomenon, that an object should only shine in dark rocky clefts, and immediately lose its brilliance when it is brought into the bright daylight, is so surprising that one can easily understand how the legends have arisen of fantastic gnomes and cave-inhabiting goblins who allow the covetous sons of earth to gaze on the gold and precious stones, but prepare a bitter disappointment for the seeker of the enchanted treasure; that, when he empties out the treasure which he hastily raked together in the cave, he sees roll out of the sacks, not glittering jewels, but only common earth. . . . On the floor of rocky caves one may discern by careful examination two kinds of insignificant-looking plant-structures, one a web of threads studded with small crumbling bodies, and the other bluish-green moss-plants resembling tiny feathers. The threads form the so-called protonema, and the green moss-plants grow up as a second generation from this protonema . . . the gleams do not issue from the green moss-plants, but only from their protonema.

"From the much branched threads . . . numerous twigs rise up vertically, bearing groups of spherical cells arranged like bunches of grapes. All the cells of a group lie in one plane, and each of these plants is at right angles to the rays of light entering through the aperture of the rocky cleft. Each of the spherical cells contains chlorophyll-granules, but in small number . . . and they are always collected together on those sides of the cells which are turned towards the dark background of the cave. . . . Taken together, these chlorophyll-granules form a layer which under low power of the microscope appears as a round green spot . . . the light which falls on such cells through the opening of a rocky cleft behaves like the light which reaches a glass globe at the further end of a dark room. The parallel incident rays which arrive at the globe are so refracted that they form a cone of light, and since the hinder surface of the globe is within this cone, a bright disc appears on it. If this disc, in which the refracted rays of light fall, is furnished with a lining, this also will be comparatively strongly illuminated by the light concentrated, on it and will stand out from the darker surroundings as a bright, circular patch. . . . It is well worthy of notice that the patch of green chlorophyll-granules on the hinder side of the spherical cell extends exactly so far as it is illumined by the refractive rays, while beyond this region, where there is no

*The grandfather of Fritz von Wettstein, famed for his work on the genetics of mosses.

illumination, no chlorophyll granules are to be seen. The refracted rays which fall on the round green spot are, moreover, only partially absorbed; in part they are reflected back as from a concave mirror, and these reflected rays give . . . a luminous appearance. This phenomenon, therefore, has the greatest resemblance to the appearance of light which the eyes of cats and other animals display in half-dark places, only illumined from one side, and so does not depend upon a chemical process, an oxidation, as perhaps does the light from a glow-worm or of the mycelium of fungi which grows on decaying wood. Since the reflected light-rays take the same path as the incident rays had taken, it is clear that the gleams of the *Schistostega* can only be seen when the eye is in the line of the incident rays of light. In consequence of the small extent of the aperture through which the light penetrates into the rock cleft, it is not always easy to get a good view. . . . If we hold the head close to the opening, we thereby prevent the entrance of the light, and obviously in that case no light can be reflected. It is, therefore, better when looking into the cave to place one's self so that some light at any rate may reach its depth. Then the spectacle has indeed an indescribable charm."

And thus the gold of the Nibelungen is reduced to scientific fact!

The spherical cells of the protonema of this "singularly brilliant vegetable" were associated with its luminous nature by Bowman as long ago as 1829 (Mag. Nat. Hist. 2: 407) and illustrated by him in 1830 (Mag. Nat. Hist. 3: 462-463. Fig. 115).

Other references of interest: Albrecht-Rohner (Ber. Schweiz. Bot. Ges. 61: 428-460. 1951), Gaisberg & Finck (Flora 120: 143-175. 1926), Johnson (Bryol. 29: 17-19. 1926), Lye (Lindbergia 1: 205-213. 1973), Toda (Jour. Coll. Sci. Tokyo 40(5): 1-30. 1918), Webster (Nat. Hist. 58: 309-311. 1949).

A similar protonema occurs in an Australian luminous moss, *Mittenia plumula* (Mitt.) Lindb., described in full by Stone (Proc. Roy. Soc. Victoria 74(2): 119-124. 1951). Mrs. Stone also presented the developmental morphology in a complete and excellent way, including the development of the peristome (Austral. Jour. Bot. 9(2): 124-151. 1961).

Some thallose liverworts of the genus *Cyathodium* (Targioniaceae) grow in caves and other poorly lighted places and emit a yellowish luminescence from their thalli.

*Schistostega* and *Mittenia* illustrate so well that mosses have fairly definite ecological requirements or, at least, preferences. The species are both structural and biological entities. This biological role is explored by Crum (Jour. Hattori Bot. Lab. 35: 269-298. 1972). Some information on habitat preferences is given in Glenn & Welch (Proc. Indiana Acad. Sci. 40: 87-101. 1931) and Welch (Bryol. 36: 11-13. 1933; Proc. Indiana Acad. Sci. 82: 105-107. 1955). Other references are given throughout this book, under *Sphagnum, Scopelophila, Mielichhoferia, Funaria, Splachnum, Ephemerum,* etc. One can get further information from Richard's summaries of the literature on ecology of bryophytes (in Verdoorn's *Manual of Bryology,* pp. 367-395. 1932; Jour. Ecol. 28: 245-248. 1940).

## BRYACEAE

Plants mostly in loose or dense, green or yellowish tufts. Stems erect (or, in *Rhodobryum,* erect from a rhizome-like primary stem), simple or forked, often densely radiculose. Leaves in many rows (rarely somewhat complanate with ± dimorphous leaves), usually small below, larger and more crowded above, often in comose tufts, usually erect or erect-spreading, rarely much altered on drying, lanceolate to ovate, usually acute, sometimes awned or hair-pointed, frequently bordered; costa single, well developed, often excurrent; upper cells elongate, typically pale, relatively large, smooth, rhomboid-hexagonal to rhomboidal or linear above, rectangular or sometimes

subquadrate at base. Perichaetia terminal (in *Mielichhoferia* at the ends of short, basal branches); perichaetial leaves not much differentiated; perigonia with filiform paraphyses. Setae ± elongate, erect or ± curved near the tip; capsules mostly inclined to pendulous, sometimes curved, usually symmetric or nearly so, ovoid, pyriform, or oblong-cylindric, with a fairly well-developed, narrow, tapered neck, nearly always smooth; annulus usually present, usually large and revoluble; operculum convex to short-conic, umbonate or apiculate, rarely short-rostrate; stomata numerous, in the neck; peristome nearly always present, rarely single and consisting of only exostome or endostome, the teeth 16, mostly lanceolate, slenderly pointed, often bordered, papillose on the outer surface, prominently trabeculate at back; endostome typically consisting of 16 delicate, pale, keeled segments from a generally well-developed basal membrane, nearly always alternating with the teeth and usually separated by 1-3 delicate cilia. Spores spherical. Calyptrae cucullate, smooth, naked.

1. Leaves linear to lanceolate, not distinctly bordered; leaf cells elongate (4:1 or longer)
  2. Leaves linear-subulate, the costa filling about ½ the base and most of the subula 1. *Leptobryum*
  2. Leaves broader, with a narrower costa 2. *Pohlia*
1. Leaves broader, ovate or ovate-lanceolate, usually distinctly bordered; leaf cells less than 4:1
  3. Stems rosulate, growing erect from an underground runner; leaves serrate above; sporophytes often clustered 4. *Rhodobryum*
  3. Stems not particularly rosulate, not growing from an underground runner; leaves entire or nearly so; sporophytes not clustered 3. *Bryum*

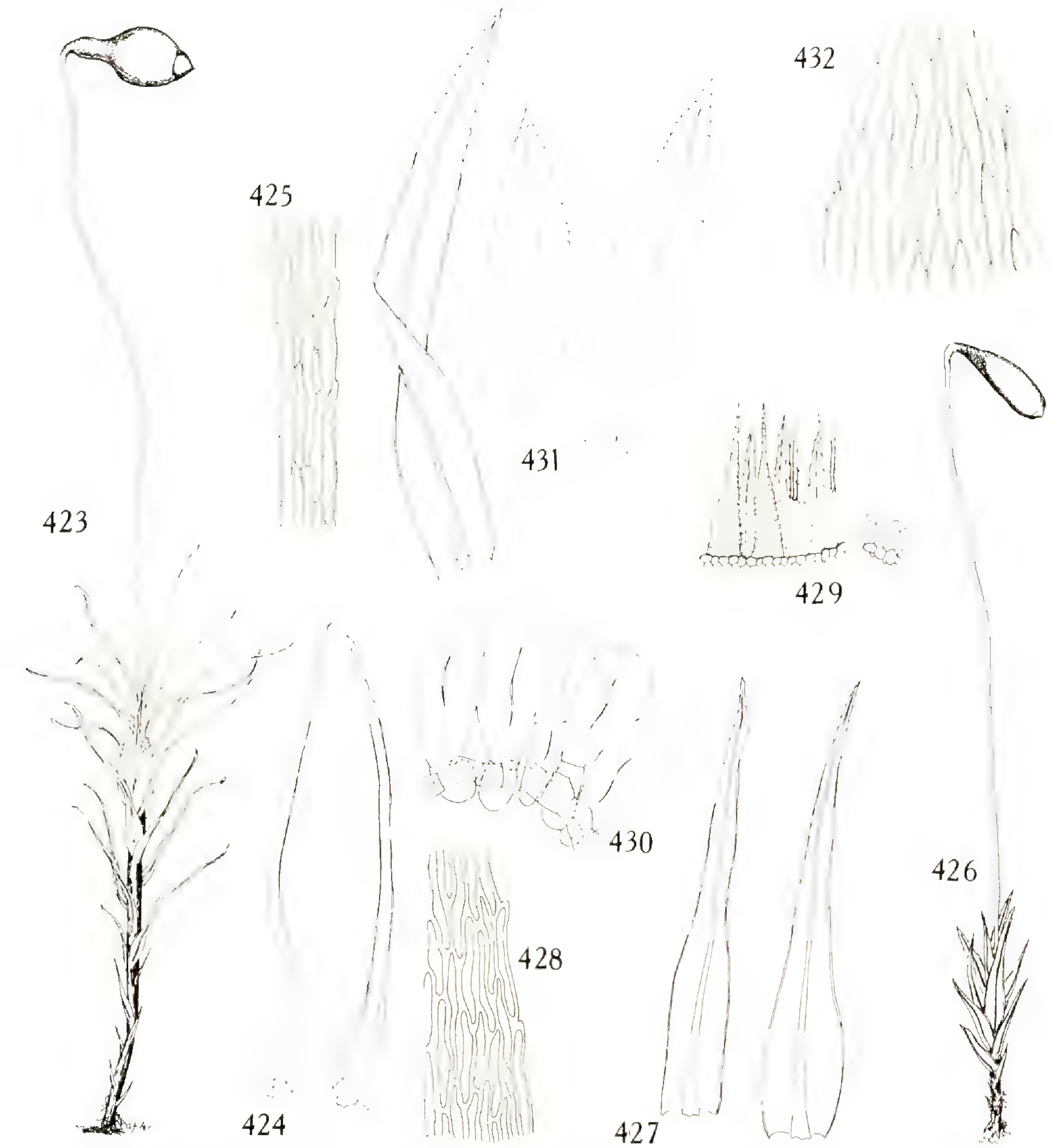
## 1. **Leptobryum** (BSG) Wils.

Slender plants in loose or dense, shiny, light- or yellow-green tufts, radiculose at base. Stems simple, erect. Leaves small and remote below, abruptly larger and crowded at the stem tips, erect- or wide-spreading, flexuose when moist, long-subulate or setaceous from a broader, oblong base; margins plane, entire or somewhat denticulate at the apex; costa very broad, filling about ½ the leaf base and most of the subula, subpercurrent to shortly excurrent; cells long-linear, broader and long-rectangular below. Setae terminal, smooth, slender, flexuose-curved; capsules strongly inclined to pendulous, pyriform from a long, narrow neck, small at the mouth, smooth, shiny; annulus revoluble; operculum convex-conic, mammillate; peristome teeth 16, lance-acuminate, yellowish, densely papillose, trabeculate; endostome hyaline, finely papillose, about as long as the teeth, with a high basal membrane, keeled and perforate segments, and well-developed, appendiculate cilia normally in 3's.—The name means slender or delicate *Bryum*.

**Leptobryum pyriforme** (Hedw.) Wils.—Plants about 0.5-1.5 cm. high (rarely more). Stems black, flexuose, rarely producing red, globose brood-bodies in leaf axils or on radicles and protonemata, regularly producing minute, reddish club-hairs in axils of upper leaves. Upper leaves 4-5 mm. long, sometimes denticulate at the tip. Synoicous or sometimes dioicous. Setae 10-45 mm. long, red-yellow or orange-brown; capsules 1.7-2.5 mm. long, brown or yellow-brown, horizontal to pendulous; cilia of endostome in 3's or occasionally in 4's. Spores 9-13 $\mu$, smooth or very finely papillose.—n = 20, 21, 22, 24.

Breen, Mosses of Florida, Pl. 64. Conard, How to Know the Mosses, (ed. 2) fig. 123. Darlington, Mosses of Michigan, fig. 73. Grout, Mosses with Hand-lens and Microscope, fig. 105, Moss Flora of North America 2: 76C. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 17, (ed. 2) Pl. 21. Welch, Mosses of Indiana, fig. 116.—**Fig. 423-425.**

On soil, rotten wood, humus, or occasionally rock in wet places, particularly in swamps, often in burned-over or otherwise disturbed habitats, common in greenhouses. Circumpolar; South




*Leptobryum pyriforme.* 423. Habit. 424. Leaves. 425. Upper cells of leaf.
*Pohlia nutans.* 426. Habit. 427. Leaves. 428. Upper cells of leaf. 429. Portion of peristome and annulus. 430. Portion of annulus enlarged.
*Pohlia cruda.* 431. Leaves. 432. Upper cells of leaf.

America, New Zealand, Tasmania, and New Guinea; Greenland to Alaska, south to California, Arizona, and New Mexico in the West, throughout eastern North America.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Biological Station campus, Colonial Point, Mill Creek, Weber Lake. EMMET CO.–Galloway Bog, Larks Lake, Wycamp Lake, Cecil Bay. MACKINAC CO.–Mackinac Island, Prentiss Bay. PRESQUE ISLE CO.–Lamprey Experiment Station, Evergreen Beach.

Dixon described this as a "very elegant and beautiful plant, both in the leaf and in the fruit." The narrow, almost setaceous leaves, suggestive of *Dicranella,* seem anomalous in the Bryaceae, but the pear-shaped capsules leave no question as to relationship. The production of brood bodies on the rhizoids enable *Leptobryum* to colonize bare soil readily and explain its common occurrence on flower pots in

greenhouses. It is interesting to observe that *Marchantia polymorpha* and *Lunularia,* also common in greenhouses, bear gemmae in large numbers, and *Ceratodon purpureus,* another invader of disturbed soils, produces gemmae on its rhizoids. (The brood-bodies of *Leptobryum* are difficult to find in dried specimens, though apparently common in living material, judging by published accounts.)

## 2. **Pohlia** Hedw.

Plants small to fairly robust, in loose or dense, green, yellowish, or rarely reddish, sometimes glossy tufts, sometimes merely gregarious. Stems simple or forked. Leaves generally crowded at the stem tips, erect or nearly so, not much altered on drying, narrow and elongate, lanceolate and acute or rarely obtuse, ± toothed near the apex, not bordered; costa ending at or below the apex; upper cells usually long and narrow, oblong-rhomboidal to linear; lower cells somewhat shorter and laxer, rectangular. Setae elongate, flexuose and twisted when dry, usually curved or hooked at the tip; capsules inclined to pendulous (or rarely suberect), symmetric or nearly so, clavate or pyriform, rarely shorter and ovoid or subcylindric, with a short or long neck, smooth; annulus usually present; operculum mostly convex-conic, mammillate or apiculate to short-rostrate; stomata sometimes ± immersed; peristome double, the 16 teeth lanceolate, yellowish or brownish, often bordered, finely papillose; endostome with a well-developed basal membrane, segments keeled and often perforate, about as long as the teeth, rarely rudimentary, and cilia rarely appendiculate (sometimes short or lacking).—Named for Johann Ehrenfried Pohl, a physician of Dresden. The genus is often confused with *Bryum,* which generally has broader leaves which are often bordered and often awned and also has much shorter leaf cells.

1. Plants producing vermicular brood-bodies in the leaf axils
 2. Plants glossy, with abundant brood bodies ..... 4. *P. proligera*
 2. Plants dull or only slightly shiny, with 1-several brood bodies per leaf axil, sometimes rather abundantly produced ..... 3. *P. annotina* var. *decipiens*
1. Plants not producing brood bodies
 3. Capsules short; exothecial cells irregularly hexagonal, with wavy walls
  4. Plants green or yellow; annulus present; stomata superficial ..... 5. *P. lescuriana*
  4. Plants with whitish-green leaves and reddish stems (particularly noticeable in contrast in the field); annulus none; stomata immersed ..... 6. *P. wahlenbergii*
 3. Capsules elongate; exothecial cells oblong, with straight walls
  5. Plants very shiny, whitish, yellowish, or bluish-green; upper leaf cells long-linear, thin-walled ..... 1. *P. cruda*
  5. Plants dull or slightly shiny, green or yellowish; upper cells rhomboidal, thick-walled ..... 2. *P. nutans*

1. **Pohlia cruda** (Hedw.) Lindb.—Plants in loose, soft, very shiny, light- or whitish-green, yellowish, or bluish tufts 1-5 cm. high. Stems simple or forked, red. Leaves gradually larger above, loosely erect or erect-spreading, not much altered on drying, 2-3.5(5) mm. long, lance-acuminate, somewhat decurrent; margins plane or narrowly reflexed, distinctly serrulate in the upper 1/2-2/3; costa ending near or considerably below the apex, usually red below, flexuose above; upper cells very long and narrow, thin-walled. Dioicous, paroicous, or occasionally synoicous. Setae 10-35 mm. long, red-yellow; capsules horizontal to pendulous (suberect when dry and empty), pale-brown, 2.5-4 mm. long, oblong-cylindric or somewhat clavate, the neck 1/3-1/2 the capsule length but not clearly differentiated when dry; annulus revoluble; operculum convex or conic, blunt or umbonate, rarely apiculate; endostome segments perforate, the cilia well-developed, ± nodulose, in 2's or sometimes 3's. Spores 13-24 $\mu$, finely papillose.—n = 10, 10+4, 11, 14, 22, 40.

Darlington, Mosses of Michigan, fig. 74. Grout, Moss Flora of North America 2: Pl. 74A.–**Fig. 431-432.**

On soil or humus in moist, shaded places, particularly in crevices of cliffs and on banks, often in the protection of overhanging turf (common in calcareous habitats). Very widespread in both Northern and Southern Hemispheres (but in uplands or mountains); Greenland to Alaska, south to North Carolina, the Great Lakes region, Nebraska, Colorado, Arizona, and California.

CHEBOYGAN CO.–Douglas Lake. EMMET CO.–Maple River, Cross Village.

In Dixon's words, this is "a very fine and beautiful species known at once by the metallic, almost opalescent sheen on the leaves." (Other species of *Pohlia* with a notable sheen are *P. proligera* and *P. bulbifera.*) The specific epithet means raw, unripened, or immature, bearing a connotation of a fresh or youthful appearance.

2. **Pohlia nutans** (Hedw.) Lindb.–Plants in loose, green or yellowish, not or somewhat shiny tufts 1-4 cm. high. Stems usually simple, red. Leaves longer and more crowded above, 2-4 mm. long, erect, not much altered when dry (but often somewhat twisted around the stem), lance-acuminate; margins ± reflexed when dry, denticulate toward the apex; costa subpercurrent; upper cells narrowly rhomboidal or linear, thick-walled. Paroicous. Setae 14-33 (rarely 50) mm. long, orange-yellow; capsules 2.5-4 mm. long, orange-brown, horizontal to pendulous, the neck about 1/3 its length, sometimes contracted when dry; annulus revoluble; operculum convex-conic, acute or bluntly apiculate; endostome segments perforate or gaping, the cilia well-developed, nodose or somewhat appendiculate, in 2's or sometimes 3's. Spores 16-21 $\mu$, finely papillose.–n = 11, 14, 21, 22, 23, 33.

Conard, How to Know the Mosses, (ed. 2) fig. 145a-d. Grout, Mosses with Hand-lens and Microscope, fig. 107, Moss Flora of North America 2: Pl. 75A. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 17, 18 & (ed. 2) Pl. 21, 22 (as *Webera nutans* & var. *triciliata*).–**Fig. 426-430.**

Common on turfy soil, decaying logs and especially tops of rotten stumps, old *Sphagnum* hummocks, and soil in rock crevices. Widespread in both Northern and Southern Hemispheres; Greenland to Alaska, south to Georgia, Arkansas, Colorado, Arizona, and California.

CHEBOYGAN CO.–Douglas Lake, Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Colonial Point, Vincent Lake, Gates Bog, Livingston Bog, Bryants Bog, Mud Lake, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.–Arnott Lake, Galloway Bog, Larks Lake, Carp Lake, Pleasantview Swamp, Stutsmanville, Wycamp Lake, Five Mile Creek. MACKINAC CO.–Bois Blanc Island, St. Martins Bay, McKays Creek, Prentiss Bay, Hog Island Point, Cut River, Epoufette, Ozark, Hendricks, Little Dollar Lake. PRESQUE ISLE CO.–Lamprey Experiment Station, Clinton Lake, Loon Lake, Shoepac Sink Holes.

The orange setae and capsules help in field identification. I recently identified *Pohlia nutans* sporophytes as a nesting material. The collector, Mrs. Nicholas L. Cuthbert of Mount Pleasant, Michigan, wrote: "The nest was about two feet above the ground in a small *Cornus racemosa* shrub and was very striking looking because of the (estimated) hundred or so moss sporophytes in the lining. It was a wet day so that the moss appeared gold-colored and was thus quite noticeable."

Clarke & Greene (Trans. Brit. Bryol. Soc. 6(1): 114-128. 1970, 6(2): 278-295. 1971) compared the reproductive behavior of *Pohlia cruda* and *P. nutans* from arctic, temperate, and subantarctic localities. They found that the paroicous *P. nutans* fruits freely in all three areas but sporophytes mature much faster in the arctic. The dioicous *P. cruda* fruits rather commonly in arctic, less commonly in temperate, and very rarely in subantarctic sites. A comparison of plants grown together in the laboratory showed considerable adaptation of reproductive processes to local environments. For example,

British plants were able to complete gametangial maturation under short or long-day conditions, but those of South Georgia matured gametangia only under long days. The length of the maturation cycle varied greatly with temperature in *P. nutans* but not in *P. cruda*. *P. nutans* could complete its maturation in warmer temperatures than *P. cruda*. South Georgia plants had a lower optimum temperature for maturation than British plants which had a lesser tolerance to frost.

The relationship of photoperiod to sporophyte development (in *Polytrichum*) was studied by Hughes (New Phytol. 61: 266-273. 1969).

**Pohlia elongata** Hedw., which grows on ledges or in crevices of cliffs in the Upper Peninsula, is somewhat similar. It is paroicous (or sometimes autoicous); its capsules have a very long neck (about as long as the urn); and the cilia of the endostome are rudimentary or lacking.

3. **Pohlia annotina** (Hedw.) Lindb.—Small plants in loose, yellow to dark-green, not or only slightly shiny tufts. Stems reddish below, bearing in leaf axils (especially toward the apex of sterile stems) 1-several small, yellowish, ovoid brood-bodies with 3-4 leaf points. Leaves not crowded, erect-spreading wet or dry, 1.2-2 mm. long, narrowly lanceolate, decurrent; margins plane (or slightly reflexed when dry), ± serrulate at the apex; costa yellowish, ending somewhat below the apex; cells rhomboidal, thin-walled. Dioicous. Setae slender and flexuose, reddish, 18-35 mm. long; capsules 2.5-3 mm. long, long-pyriform, with a distinct, narrow neck about as long as the urn, horizontal to pendulous, brown when mature; annulus revoluble; operculum conic or convex and mammillate; exothecial cells rounded-hexagonal, with slightly wavy walls; endostome segments perforate, the cilia in groups of 2-4. Spores 18-22 $\mu$, finely papillose.

Grout, Moss Flora of North America 2: Pl. 78 (fig. 2).—**Fig. 433-435.**

Not found in our area, the typical variety has been found in nearby Chippewa County (on Sugar Island) and also in Alger County. Europe and the Azores; Asia Minor and Siberia; Greenland; British Columbia to California and Idaho; Michigan and Ontario to New York and New Hampshire.

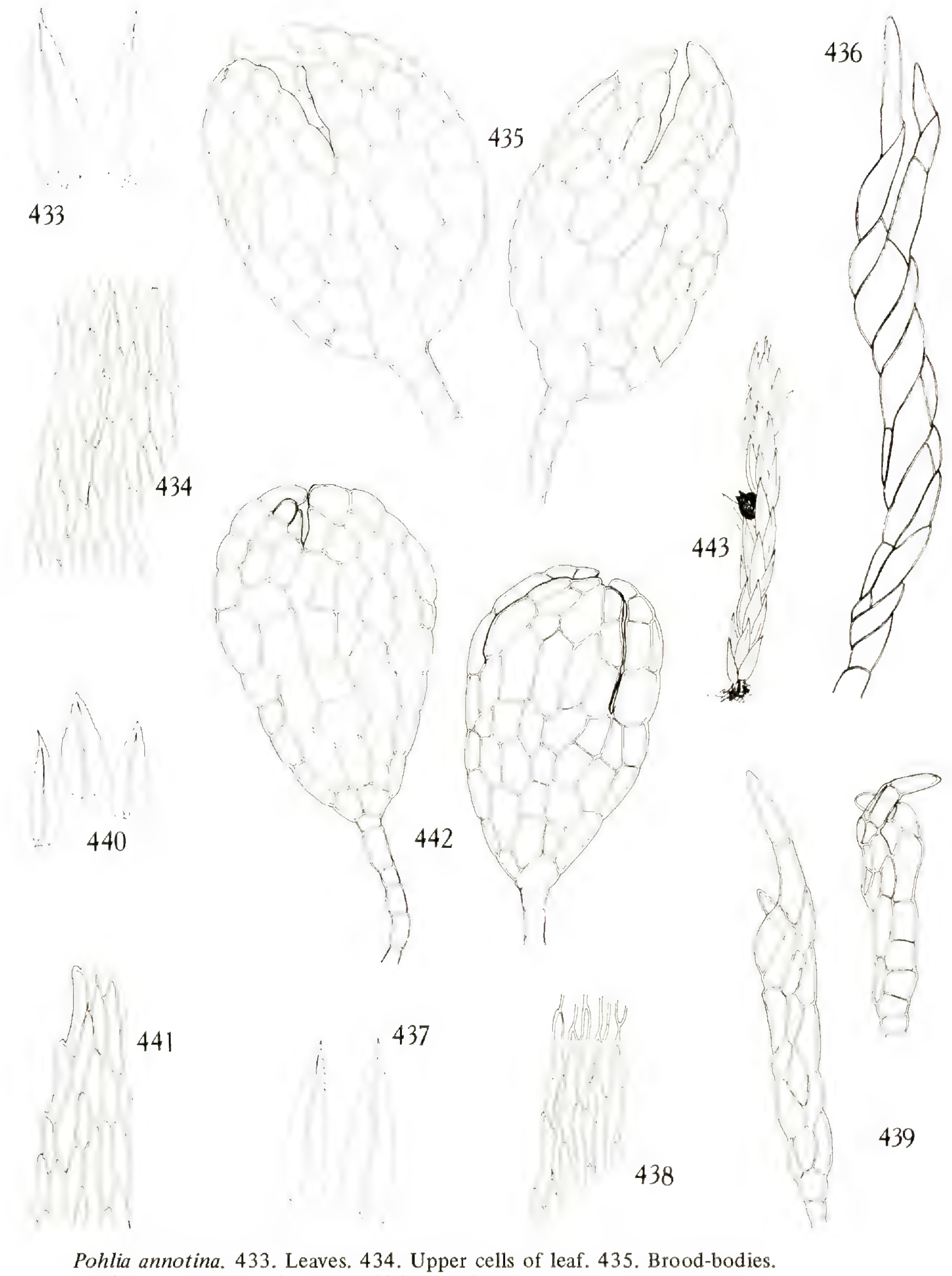
Var. **decipiens** Loeske (var. *loeskei* Crum, Steere & Anders.)—Brood-bodies small, yellow or pale-rusty, shortly vermicular, twisted, 1-several in the leaf axils.

Conard, How to Know the Mosses (ed. 2) fig. 145e. Grout, Moss Flora of North America 2: Pl. 78 (fig. 1L).—**Fig. 436.**

On soil in moist, open places, especially near lakes and ponds or in ditches. Europe; southeastern Alaska to Washington and Idaho; New Brunswick to Wisconsin, south to Georgia and Iowa.

CHEBOYGAN CO.—Vincent Lake.

Wilczek & Demaret (Bull. Jard. Bot. Nat. Belg. 40: 405-422. 1970) found that in plants grown in culture slender, twisted propagula (as in *P. annotina* var. *decipiens*) represent a young stage of growth, longer, cylindric and obovoid ones (as in *P. proligera*) a somewhat older stage, and large, ovoid or obovoid ones (as in *P. annotina* var. *annotina*) a mature stage. Consequently they recognized only one species. I reserve judgment, at least as regards *P. proligera*, as I have never had trouble recognizing it by the size, shape, and luster of its leaves. They may be right in considering *P. annotina* var. *decipiens* a mere developmental form. However, its range in eastern North America is significantly different from that of the typical variety. From *P. proligera*, the var. *decipiens* is distinguished by a relatively dull appearance and twisted brood bodies.




*Pohlia annotina*. 433. Leaves. 434. Upper cells of leaf. 435. Brood-bodies.
*Pohlia annotina* var. *decipiens*. 436. Brood-body.
*Pohlia proligera*. 437. Leaves. 438. Upper cells of leaf. 439. Brood-bodies.
*Pohlia bulbifera*. 440. Leaves. 441. Upper cells of leaf. 442. Brood-bodies.
*Pohlia rothii*. 443. Habit.

4. **Pohlia proligera** (Kindb. *ex* Limpr.) Lindb. *ex* Arn.–Plants small and slender, gregarious or loosely tufted, glossy, green, yellowish, or occasionally red-tinged. Stems simple, red; brood-bodies very numerous in axils of upper leaves, small, vermicular, with 1-3 leaf primordia, green to yellow or rusty. Leaves erect or spreading and often

± flexuose or twisted when dry, erect- to wide-spreading when moist, soft, 1-1.5 mm. long, rather broadly oblong-lanceolate, acute, ± decurrent; margins plane or somewhat reflexed, slightly serrulate toward the apex; costa subpercurrent or ending somewhat below the apex; cells linear-rhomboidal, thin-walled. Dioicous. Setae 20-40 mm. long, slender and flexuose; capsules horizontal to pendulous, 2.5-3 mm. long, shortly oblong-cylindric and short-necked; annulus revoluble; operculum convex-conic; exothecial cells short with wavy outlines; endostome segments perforate, the cilia in 2's and 3's, nodulose. Spores 16-18 $\mu$, finely papillose.–n = 11.

Grout, Mosses with Hand-lens and Microscope, fig. 109, Moss Flora of North America 2: Pl. 78 (fig. 1, A-K).–**Fig. 437-439.**

On moist disturbed soil of roadbanks, also in crevices of cliffs. Europe; Greenland to Alaska and south to California, Colorado, Michigan, and New York.

MACKINAC CO.–Cut River.

The conspicuous sheen and the small size provide an easy means of identification. The brood-bodies have been aptly compared to an empty glove.

**Pohlia bulbifera** (Warnst.) Warnst. (fig. 440-442), which occurs on Sugar Island (Chippewa Co.), is a glossy plant with 1-3 obovoid or top-shaped, yellowish brood-bodies per leaf axil. *P. annotina* has leaves less glossy and brood-bodies ovoid and not tapered to the base.

Not yet discovered in Michigan is **Pohlia rothii** (Corr. *ex* Limpr.) Broth. (fig. 443), which has glossy leaves and produces singly in the leaf axils large, red, ovoid gemmae with rather well-developed leaf points.

5. **Pohlia lescuriana** (Sull.) Grout–Small, gregarious or loosely tufted, dull or somewhat shiny, green or yellow plants about 4-7 mm. high. Leaves 1.5-3 mm. long, narrowly lance-acuminate; margins narrowly recurved, slightly and remotely serrulate near the apex; costa ending near the apex; cells long, linear-rhomboidal. Dioicous. Setae 9-17 mm. long, orange-brown or red; capsules about 1 mm. long, shortly pyriform from a short, distinct neck, horizontal to pendulous, brownish; annulus well differentiated in 1 row, deciduous; operculum convex, apiculate; stomata superficial (or slightly sunken, but scarcely immersed); exothecial cells irregularly hexagonal, with walls somewhat wavy and thickened at the corners; endostome segments perforate, the cilia well-developed, slightly nodulose, in groups of 2-3. Spores 15-20 $\mu$, faintly roughened.

Grout, Mosses with Hand-lens and Microscope, Pl. 45. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 18 (as *Webera*), (ed. 2) Pl. 22 (as *Pohlia pulchella*).–**Fig. 444.**

On damp soil of roadbanks or on banks of streams and ditches. Circumpolar; Nova Scotia to Michigan and Iowa, south to Ohio and the District of Columbia.

MACKINAC CO.–Mackinac Island.

The very small, shortly pyriform capsules and the short exothecial cells with wavy walls thickened at the corners are recognizable features of this rare species.

6. **Pohlia wahlenbergii** (Web. & Mohr) Andr.–Plants in extensive, loose or dense, soft tufts 1.5-7 cm. high, whitish- or glaucous-green when moist, pale green, yellowish, or brownish when dry, not shiny. Stems reddish, forked. Leaves rather distant, erect or

erect-spreading, slightly twisted when dry, 1.2-2.6 mm. long, lanceolate or ovate-lanceolate, acute, slightly to distinctly decurrent; margins plane or somewhat reflexed below, especially when dry, serrulate toward the apex; costa yellowish or reddish, ending near the apex; upper cells rather lax and thin-walled, oblong-rhomboidal, 3-7:1, somewhat narrower toward the margins. Dioicous; perigonia large and conspicuous, cupulate, the bracts with spreading points. Setae 25-40 mm. long, slender and flexuose; capsules pendulous, 1.5-2 mm. long, shortly oblong-ovoid from a short neck; annulus none; operculum low-conic, apiculate; exothecial cells hexagonal, with slightly irregular outlines, not or slightly collenchymatous; stomata immersed; endostome segments perforate, the cilia nodulose, in 2's and 3's. Spores 15-20 $\mu$, minutely papillose.—n = 10, 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 144. Grout, Mosses with Hand-lens and Microscope, Pl. 46 (as *Mniobryum albicans*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 18 & (ed. 2) Pl. 22 (as *Mniobryum*). Welch, Mosses of Indiana, fig. 118.–**Fig. 445-448.**

On wet soil or rock in seepage around springs, also in ditches and in the overflow of brooks. Circumpolar; also North Africa, South America, and Kerguelen; Greenland to Alaska, south to North Carolina, Arkansas, and Guatemala.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Burt Lake. EMMET CO.–Maple River, Big Stone Bay. MACKINAC CO.–Bois Blanc Island, St. Martins Point, Epoufette. PRESQUE ISLE CO.–Lamprey Experiment Station, Evergreen Beach, Ocqueoc River.

Easily recognized in nature by the seepy habitat and soft, whitish leaves contrasting with red stems. Dried plants lose this whiteness and contrast and may be mistaken for *Philonotis fontana,* which is larger, coarser, densely tufted, and glaucous-white (differing more in texture than in color).

**Pohlia filiformis** (Dicks.) Andr., a rare montane species occurring in the Lake Superior region, differs from all our other Pohlias in having small, julaceous stems with shiny leaves which are erect or appressed, concave, broad (ovate-lanceolate to subelliptic) and broadly pointed to obtuse and apiculate.

## 3. **Bryum** Hedw.

Small to robust plants, gregarious to densely tufted. Stems mostly forked, often radiculose. Leaves usually small and remote below, larger and more crowded above, sometimes in ± rosulate tufts, erect-appressed to erect-spreading, usually not much altered on drying, ± concave, mostly rather broad, ovate to elliptic or lanceolate, sometimes decurrent, usually acute or acuminate, sometimes awned, rarely obtuse or rounded, often bordered by narrow cells; costa strong, rarely ending below the apex, often excurrent; upper cells usually rather broad and transparent, mostly rhomboid-hexagonal; lower cells rectangular. Setae terminal, elongate, curved or hooked at the tip; capsules mostly nodding or pendent, subcylindric, clavate, or pyriform, rarely ovoid or subglobose, symmetric or somewhat curved, especially in the neck which is well developed and usually evident, smooth; annulus revoluble; operculum convex or conic, umbonate or rarely apiculate; peristome double, the 16 teeth lanceolate, slenderly acuminate, yellow-brown, mostly hyaline at the tips, papillose on the outer surface, often bordered, trabeculate at back; endostome with a well-developed basal membrane, keeled and usually perforate segments (very rarely lacking), and slender, often nodose or appendiculate cilia (rarely rudimentary or lacking).—A Greek word for moss, used by Dioscorides for some cryptogam and applied by Dillenius to this genus and its relatives. A large and difficult genus–the *Crataegus* of bryology. Specific

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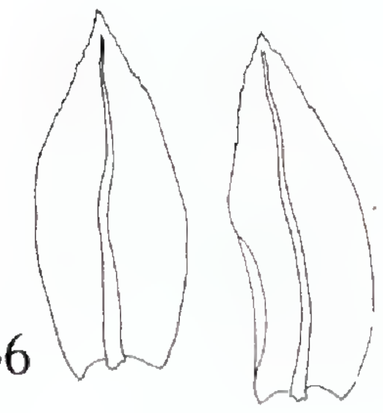

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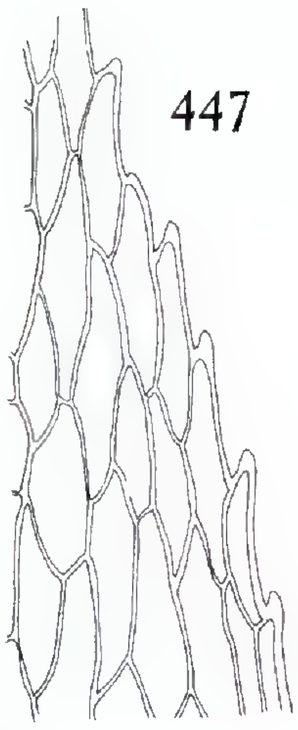

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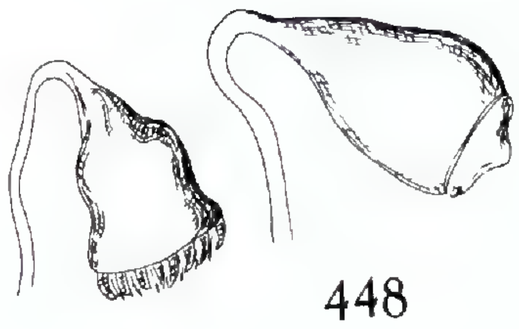

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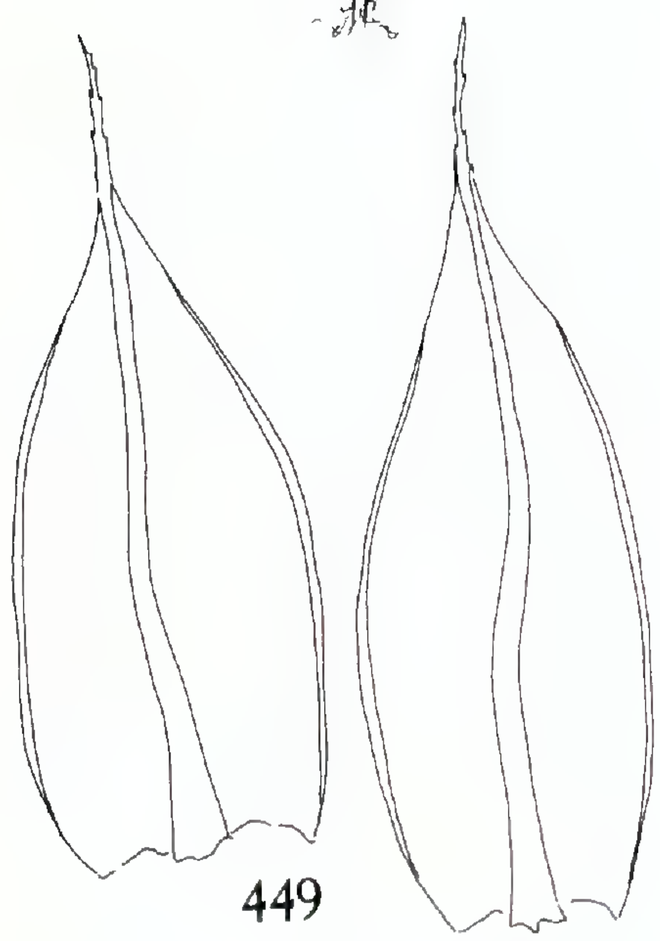

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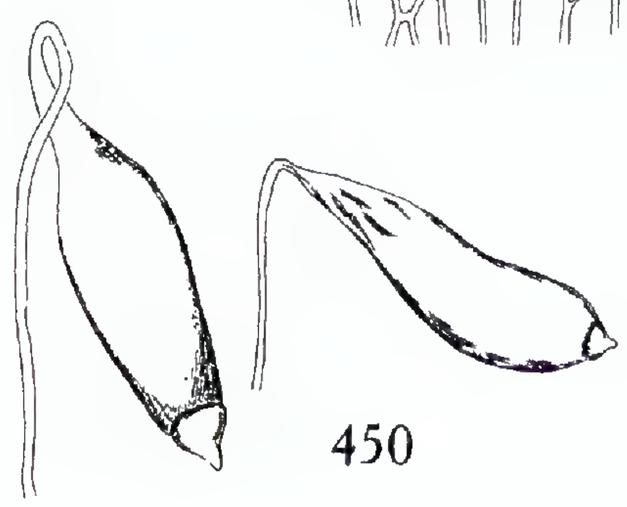

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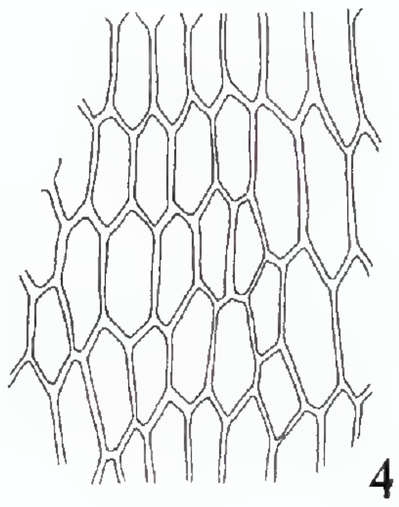

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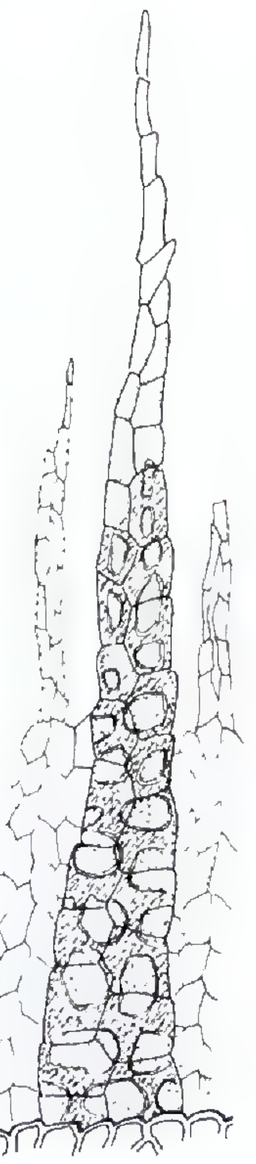


452

*Pohlia lescuriana.* 444. Habit.

*Pohlia wahlenbergii.* 445. Habit. 446. Leaves. 447. Upper cells of leaf. 448. Capsules, wet and dry.

*Bryum algovicum.* 449. Leaves. 450. Upper cells of leaf. 451. Capsule. 452. Portion of peristome.

characters are based primarily on sexual conditions and details of the peristome. Fortunately, the seven species in our area are easily separated, and three of them can be recognized in a sterile condition and in the field.

1. Endostome with cilia rudimentary or lacking
   2. Leaf margins revolute; polygamous; capsules rarely 4 mm. long; endostome adherent to exostome in the lower ½ or more; lamellae at back of exostome teeth extensively joined by vertical walls ..... 1. *B. algovicum*
   2. Leaf margins not or slightly revolute; autoicous; capsules unusually long and slender, 4-6 mm. long; endostome free; lamellae at back of exostome teeth not extensively joined by vertical walls ..... 2. *B. uliginosum*
1. Endostome with cilia well developed
   3. Small, silvery, julaceous plants; upper leaf cells hyaline, conspicuously differentiated from lower cells ..... 3. *B. argenteum*

3. Larger plants, not silvery or julaceous; upper cells not hyaline or conspicuously differentiated from lower cells
 4. Costa not or rarely somewhat excurrent
  5. Leaves noticeably decurrent (especially on sterile stems); leaf margins revolute throughout; upper cells thick-walled — 5. *B. pseudotriquetrum*
  5. Leaves not particularly decurrent; leaf margins ± reflexed below; upper cells lax and thin-walled — 4. *B. capillare*
 4. Costa regularly and distinctly excurrent
  6. Synoicous; upper cells 3-4:1 — 6. *B. lisae* var. *cuspidatum*
  6. Dioicous; upper cells about 7:1 — 7. *B. caespiticium*

1. **Bryum algovicum** Sendtn. *ex* C. M.—Plants variable in size but usually about 5 mm. high, densely tufted, often radiculose below, green or yellowish-green. Leaves erect and slightly contorted when dry, erect-spreading when moist, somewhat larger, more crowded, and spreading at the stem tips, ovate-lanceolate, slenderly long-acuminate, somewhat decurrent; margins revolute; costa reddish at base, long-excurrent, remotely toothed near the tip; upper median cells oblong-hexagonal, about 2-3:1, fairly thick-walled, gradually narrowed toward the margins forming an ill-defined border, longer and narrower in the acumen. Polygamous (usually synoicous, but often appearing autoicous or dioicous; innovations on fruiting plants often ending in a perigonium). Setae (4)15-40 (rarely 60) mm. long, red or red-brown; capsules pendulous, 1.5-3.5, rarely 4 mm. long, pyriform to clavate-cylindric, with a well-developed neck; operculum small, convex-conic, mammillate to apiculate; peristome teeth brown and opaque below, hyaline above, the lamellae at back extensively joined by vertical walls; endostome well developed but usually adhering to the exostome in the lower half or more, the segments perforate, the cilia none or 1-2 and irregularly developed. Spores 18-37 $\mu$ (somewhat variable in size even in the same capsules), finely papillose to nearly smooth.—n = 10, 27, 30.

Conard, How to Know the Mosses, (ed. 2) fig. 148e (as *B. pendulum*). Grout, Moss Flora of North America 2: Pl. 84 & 97B (as *B. pendulum*). Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 22 (as *B. angustirete*). Welch, Mosses of Indiana, fig. 119 (as *B. pendulum*).—**Fig. 449-452.**

On sand or gravel, often in seepage; locally in depressions in low dunes near Lake Michigan and Lake Huron. Circumpolar; Greenland to Alaska and south to the District of Columbia, Ohio, Illinois, Colorado, and Arizona.

EMMET CO.—Cecil Bay, Big Stone Bay, Waugoshance Point. PRESQUE ISLE CO.—Grace Harbor, Evergreen Beach.

*Bryum algovicum* grows in the sands along the shores of the Great Lakes, usually in depressions which are wet or seepy during part of the year. It has the ability to continue growth through successive layers of sand. Its unmistakable feature, the chambered appearance of the peristome caused by the adherence of endostome to exostome around air spaces, is often best observed microscopically before complete soaking. With a handlens, the species can be recognized by the apparent absence of the endostome and the tendency for the teeth to stand erect rather than incurved, as in mosses with endostome and exostome separate.

2. **Bryum uliginosum** (Brid.) BSG—Plants in loose or dense, green, yellowish, or brownish tufts, rarely more than 10 mm. high. Leaves equally spaced, not particularly crowded, erect and contorted when dry, erect-spreading when moist, up to 5 mm. long, ovate-lanceolate, long-acuminate, not decurrent; margins not or slightly revolute, serrulate near the apex; costa yellowish, percurrent or short-excurrent; cells relatively lax and thin-walled, oblong-hexagonal or short-rhomboidal, about 3-3.5:1 above, linear in several marginal rows forming a well-marked border. Autoicous; perigonia small and

inconspicuous, at the ends of short branches. Setae usually very long, 25-75 mm. long, red or red-yellow; capsules suberect to horizontal or ± pendulous, 4-6 mm. long, clavate or clavate-cylindric (typically very long and slender), oblique at the mouth, the well-defined neck usually about as long as the urn, ± curved; operculum convex-conic, sometimes apiculate; peristome teeth yellow-brown; endostome segments rather broad, cilia none or rudimentary (or occasionally long and nodulose but weak and coherent, in 3's). Spores 18-29 $\mu$, finely papillose.—n = 10.

Conard, How to Know the Mosses, (ed. 2) fig. 148a-d. Grout, Moss Flora of North America 2: Pl. 87 below (as *B. cernuum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 18 (as *B. cernuum*).—**Fig. 453-455.**

On peaty or sandy banks of streams or on rotten wood in wet places, probably a calciphile. Circumpolar; Labrador to Manitoba, south to New York and Illinois; in the West, from British Columbia and Alberta to Oregon; Texas and New Mexico.

CHEBOYGAN CO.—Iron Bridge (over Carp Creek).

A great rarity in eastern North America, known locally from a single locality; best recognized by the long setae and long, slender capsules.

3. **Bryum argenteum** Hedw.—Small plants in loose or dense, whitish or silvery tufts 3-12 mm. high. Stems reddish, forked. Stem leaves few, ovate-lanceolate. Branch leaves imbricate wet or dry, concave, 0.5-1.2 mm. long, broadly ovate, apiculate to filiform-acuminate, not bordered; margins entire, plane or slightly reflexed below; costa slender, reddish at base, ending well below the apex or disappearing in the acumen; upper cells rhomboidal, hyaline and rather thin-walled toward the apex, thicker-walled and yellowish below, and subquadrate to short-rectangular and reddish in an extensive basal area. Dioicous. Setae 8-20 mm. long, red; capsules 1-2 mm. long, pendulous to pendent, oblong-cylindric from a short neck, usually red; operculum low-conic, blunt to acute or apiculate; peristome teeth brownish below, hyaline above; endostome segments keeled and perforate, the cilia nodose to appendiculate, in 2's and 3's. Spores 10-15 $\mu$, smooth or faintly roughened.—n = 9+1, 10, 10+1, 11, 12 (as var. *lanatum*), 20.

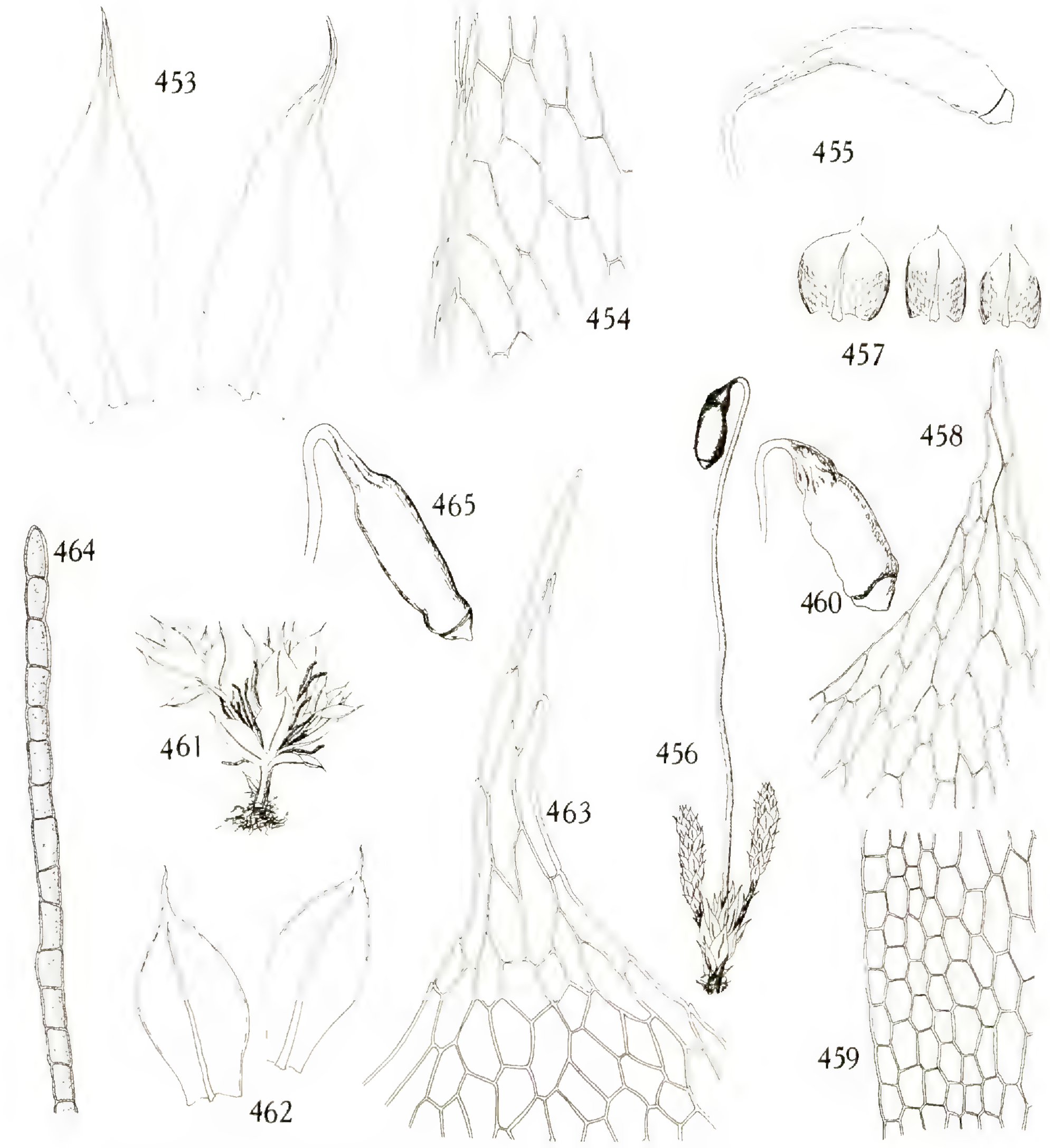
Conard, How to Know the Mosses, (ed. 2) fig. 149. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 20, (ed. 2) Pl. 24.—**Fig. 456-460.**

On bare soil in disturbed places, in old fields, along roads, in paths, in cracks of sidewalks, etc. Cosmopolitan; widespread in North America.

CHEBOYGAN CO.—Biological Station campus, Iron Bridge, Colonial Point, Riggsville, Duncan Bay, Weber Lake. EMMET CO.—Alanson, Cross Village, Five Mile Creek, Ramona Beach, Cecil Bay. MACKINAC CO.—Mackinac Island, Nunns Creek, Bush Bay.

The SILVERY BRYUM is easily recognized by the color of the leaves which are crowded together on small, catkin-like innovations. The pink or red capsules are attractive in contrast with the silvery gametophytes. The species is a ubiquitous weed, thriving even in the atmospheric pollution of large cities. It is a pronounced nitrophile, occurring in tell-tale abundance in urine-soaked soils around Eskimo habitations in the Arctic, for example, or around dog kennels.

4. **Bryum capillare** Hedw.—Dark-green or brownish plants in dense tufts usually less than 10 mm. high. Filiform, brown, papillose brood-bodies often clustered in leaf axils. Leaves erect and usually ± spirally contorted when dry, erect-spreading when




*Bryum uliginosum.* 453. Leaves. 454. Upper cells. 455. Capsule.

*Bryum argenteum.* 456. Habit. 457. Leaves of julaceous branches. 458. Upper cells of leaf. 459. Cells at basal margin of leaf. 460. Capsule.

*Bryum capillare.* 461. Habit. 462. Leaves. 463. Upper cells of leaf. 464. Brood-body. 465. Capsule.

moist, elliptic to obovate, abruptly cuspidate to awned; margins plane or variously reflexed, serrulate toward the apex; costa ending well below the apex to long-excurrent; upper cells oblong-hexagonal, 1.5-3:1, green, thin-walled, with 1-2 (rarely 4) rows of linear cells in a pale, narrow, unistratose border. Dioicous. Setae about 20-35 mm. long; capsules inclined to pendulous, clavate-cylindric, 2.5-4.5 mm. long; operculum convex-conic, apiculate; cilia 1-4, appendiculate. Spores 8-15 $\mu$, nearly smooth.—n = 9, 10, 10+1, 10+2, 10+2-3, 12, 15, 20, 24.—Most, if not all collections from eastern North America belong to the var. **flaccidum** (Brid.) BSG, a lax expression of the species with remote leaves only moderately spiral-contorted when dry and typically provided with axillary, filiform brood-bodies. The range of the variety is probably much like that of the species.

Breen, Mosses of Florida, Pl. 62 (figs. 1-4). Conard, How to Know the Mosses, (ed. 2) fig. 151e. Grout, Mosses with Hand-lens and Microscope, Pl. 48. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 20, (ed. 2) Pl. 24.–**Fig. 461-465.**

On rock, soil, or humus, especially on banks, commonly on bark at base of trees or in crotches or drainage channels on tree trunks. Circumpolar; Aleutian Islands and across the continent of North America south to California, Arizona, Texas, and Florida; Mexico, Central America, Chile; West Indies.

CHEBOYGAN CO.–Riggsville, Little Lake 16, Colonial Point, south end of Burt Lake, Mill Creek, Weber Lake. EMMET CO.–Pellston Hills, Cross Village, Five Mile Creek, Cecil Bay, Big Stone Bay. MACKINAC CO.–Cut River, Ozark, Caffey Corner, Little Dollar Lake.

The spirally contorted, dark-green leaves with thin-walled cells are distinctive, and with a little practice, *Bryum capillare* can be recognized in the field by an aspect rather like that of a *Mnium*. The brown, filiform brood-bodies, looking like stout rhizoids, also help.

5. **Bryum pseudotriquetrum** (Hedw.) Gärtn., Meyer & Scherb.–Relatively robust plants, in dense, dark-green or reddish tufts, radiculose below, 1.5-5, sometimes 11 cm. high. Stems simple or forked, red, rarely felted above with filamentous, brown brood-bodies, ± tomentose below. Leaves usually rather remote below, somewhat larger and more crowded above, twisted and contorted when dry, erect-spreading when moist, 2.5-4 mm. long, oblong-lanceolate to ovate-lanceolate, acute (and often cuspidate) to acuminate, narrow at the insertion and narrowly but distinctly decurrent; margins entire or serrulate near the apex, strongly revolute throughout; costa red below, red or brownish above, percurrent or short-excurrent; upper cells oblong-hexagonal, 2-3:1, with firm walls, linear and very thick-walled in several marginal rows forming a strong, often colored border. Dioicous or synoicous. Setae 25-60 mm. long, dark-red below, red-brown above; capsules 3-4 mm. long, inclined to pendulous, usually straight, clavate, the neck sometimes as long as the urn; operculum large, convex-conic, apiculate; peristome teeth brownish-yellow; cilia of endostome well-developed, appendiculate, in 3's (or sometimes also in 2's and 4's). Spores 11-20 $\mu$, smooth or faintly roughened.–n = 9, 10, 10+1, 11, 20, 22.

Conard, How to Know the Mosses, (ed. 2) fig. 152a-c. Darlington, Mosses of Michigan, fig. 75. Grout, Mosses with Hand-lens and Microscope, Pl. 47 (as *B. binum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 19 & (ed. 2) Pl. 23 (as *B. binum*). Welch, Mosses of Indiana, fig. 122.–**Fig. 466-470.**

On wet soil or humus, sometimes on rocks or decayed wood, common in swamps and near brooks and ponds. Circumpolar; South America; Greenland to Alaska, south to California, Colorado, Arkansas, and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Vincent Lake, Livingston Bog, Inverness Township, Mud Lake, Duncan Bay, Grass Bay, Mill Creek, Trout Creek. EMMET CO.–Pleasantview Swamp, Carp Lake, Arnott Lake, Galloway Bog, Wycamp Lake, Cecil Bay, Big Stone Bay, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Bay, McKays Creek, Cut River, Ozark. PRESQUE ISLE CO.–Evergreen Beach, Hammond Bay, Mast Point, Grace Harbor, Rainy River Falls, Clinton Lake.

Very common in wet habitats and easy to recognize in a sterile state because of red stems and obviously decurrent leaves with rather broad points. It has often been confused with **B. weigelii** Spreng., which occurs in more northerly parts of Michigan and has soft leaves, shriveled when dry, with lax, thin-walled cells and an indistinct border.

**Bryum tortifolium** Funck *ex* Brid., which occurs on Sugar Island in nearby Chippewa County, can be characterized as follows: weak, slender plants in soft, loose, green to yellow-brown tufts; leaves oblong-ovate to elliptic, rounded at the apex, inconspicuously decurrent, plane and entire at the margins; costa ending somewhat below the apex; cells 2-5:1, rather thin-walled, longer and narrower in a few marginal rows in an indistinct border. Dioicous; peristome complete, with appendiculate cilia. It has been confused with red plants of the arctic properly referred to **B. cryophilum** Mårt. It is larger and has leaves with more distinctly differentiated borders which are very narrowiy revolute below.

6. **Bryum lisae** De Not. var. **cuspidatum** (BSG) Marg.–Plants in dense, green or yellowish tufts usually scarcely more than 1 cm. high. Leaves small and distant below, larger and crowded above, moderately contorted when dry, oblong-lanceolate to ovate-lanceolate, acuminate, ending in a smooth or ± toothed point formed of the ± long-excurrent costa; margins revolute nearly to the ± serrulate apex, distinctly bordered; upper cells rhomboidal (about 3-4:1), usually longer in the acumen, linear in 2-5 marginal rows. Synoicous. Setae up to about 2.5 cm. long; capsules horizontal to subpendulous, up to about 3 mm. long, the neck generally somewhat shorter than the rest of the capsule; annulus revoluble; operculum convex and apiculate; cilia of endostome in 2's and 3's, appendiculate. Spores 11-18 $\mu$, finely papillose.–n = 10, 20, also 22 and 30 (as *B. affine*).

Grout, Moss Flora of North America 2: Pl. 92B (as *B. cuspidatum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 19 (as *B. affine* & *B. intermedium*), (ed. 2) Pl. 23. Welch, Mosses of Indiana, fig. 120 (as *B. cuspidatum*).–**Fig. 471-473.**

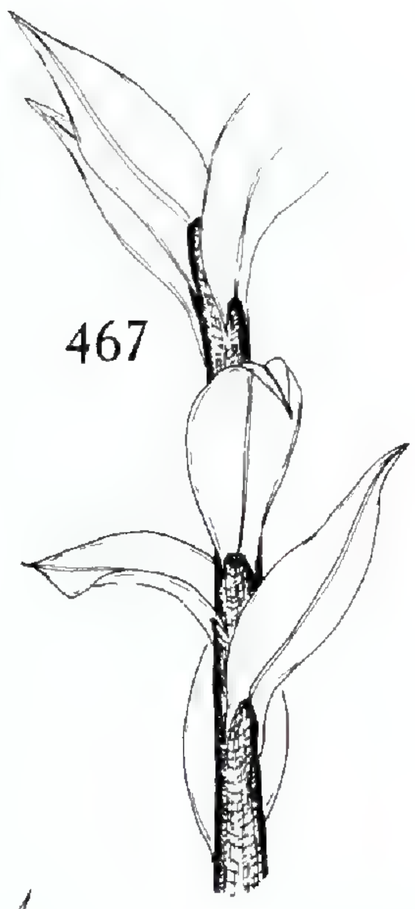
A weed, on rocky or sandy, often wet soild in disturbed places, especially on roadbanks or sides of ditches, sometimes also on rock, humus, or rotten wood. Circumpolar; widespread in North America.

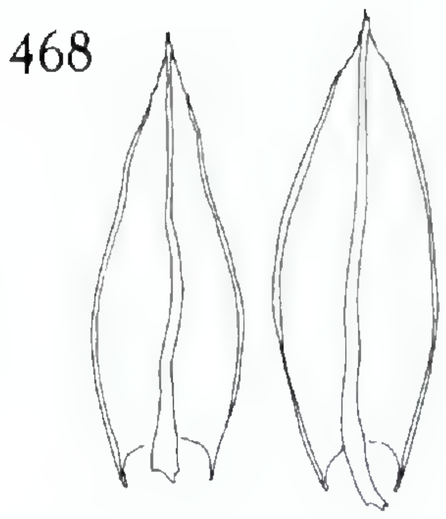
CHEBOYGAN CO.–Reeses Bog, Gorge of Carp Creek, Douglas Lake, Smiths Bog, Ellis Township, Long Lake, Mill Creek, Little Lake 16, Weber Lake. EMMET CO.–Conway Bog, Wycamp Lake. PRESQUE ISLE CO.–Presque Isle Lighthouse, Hammond Bay, Evergreen Beach.

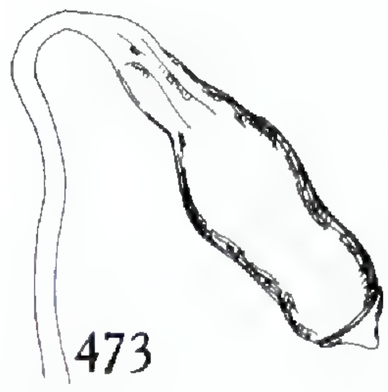
Recognized by its weedy habitat, perfect peristome, and synoicous inflorescence, it is most likely to be confounded with *B. caespiticium*.

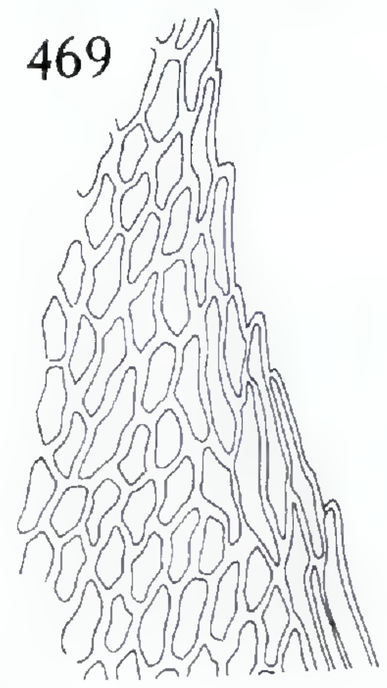
The name *Bryum cuspidatum* (BSG) Schimp., so long in use for this common and widespread species, is nomenclaturally unacceptable (being a later homonym), and *B. creberrimum* Tayl., recently in use as a replacement, has proved to be something else. Until various synonyms at the specific level can be tested and verified, one can use the name *B. lisae* var. *cuspidatum*.

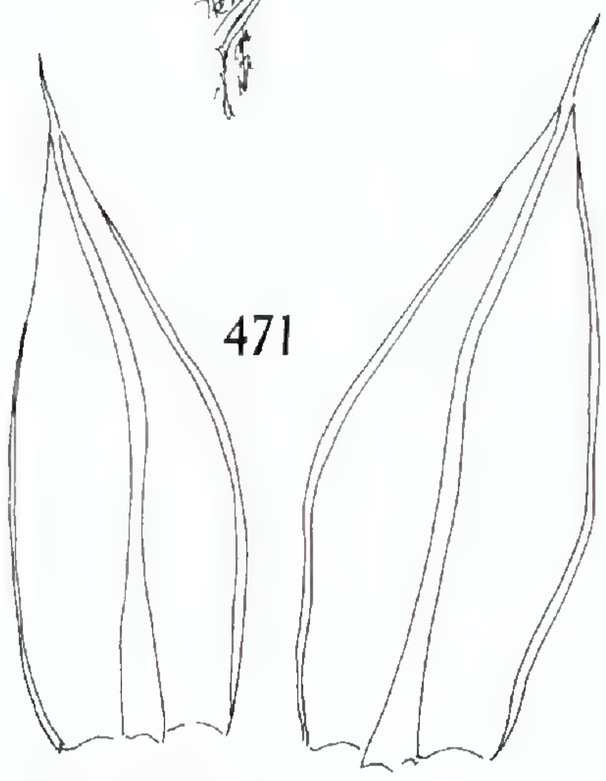
7. **Bryum caespiticium** Hedw.–Plants densely caespitose or gregarious and mixed with other mosses, light- or yellow-green, rarely more than 1 cm. high. Leaves small and distant below, larger and crowded above, ovate-lanceolate, long-acuminate; margins revolute, entire or slightly serrulate in the apex; costa red at base, yellowish above, long-excurrent as a smooth or slightly serrulate point; upper cells rhomboidal, about 7:1, somewhat longer toward the apex and the margin but not forming a distinct border; basal cells broader and shorter, the alar cells subquadrate. Dioicous. Setae up to 3 cm. long; capsules inclined to pendulous, up to 4 mm. long, clavate to oblong-obovoid, sometimes curved, the neck shorter than the rest of the capsule; annulus revoluble; operculum short-conic; stomata in the neck; cilia of endostome in groups of 3-4, appendiculate. Spores 12-15 $\mu$, or nearly smooth.–n - 9+1, 10, 10+1, 10+5, 11, 20, 20+1 (and, experimentally, 20, 40, etc.).

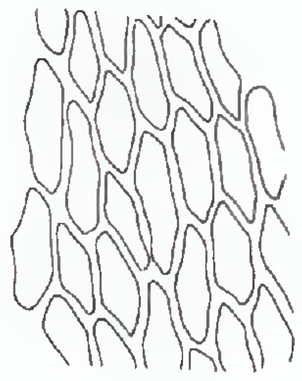


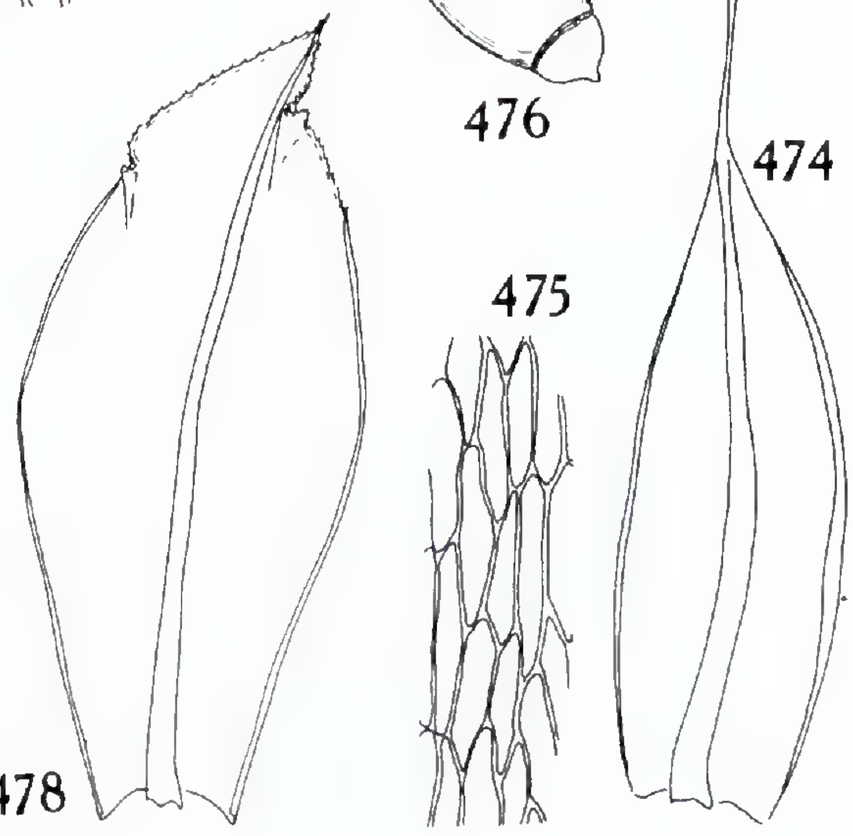



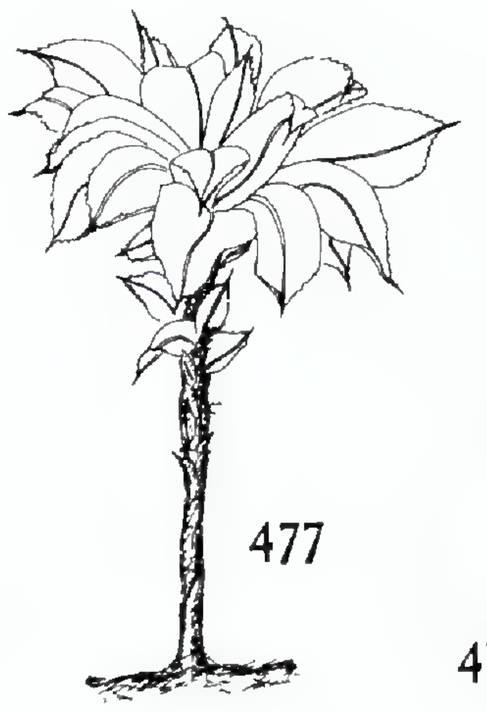







*Bryum pseudotriquetrum.* 466. Habit. 467. Portion of sterile stem showing decurrent leaves. 468. Leaves. 469. Upper cells of leaf. 470. Capsule.

*Bryum lisae* var. *cuspidatum.* 471. Leaves. 472. Upper cells of leaf. 473. Capsule.

*Bryum caespiticium.* 474. Leaf. 475. Upper cells of leaf. 476. Capsule.

*Rhodobryum roseum.* 477. Habit. 478. Leaf. 479. Upper cells at margin of leaf.

Conard, How to Know the Mosses, (ed. 2) fig. 151a-d. Grout, Mosses with Hand-lens and Microscope, fig. 113. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 20, (ed. 2) Pl. 24. Welch, Mosses of Indiana, fig. 121.–**Fig. 474-476.**

On soil in disturbed places. Circumpolar; Tasmania and New Zealand; widespread in North America.

CHEBOYGAN CO.–Reeses Bog, Colonial Point. EMMET CO.–Pellston, Big Stone Bay.

Like many species of *Bryum, B. caespiticium* is based on highly technical characters. I recognize it by its weedy habitat, perfect peristome, and dioicous inflorescence. (It has narrower leaf points with longer cells and a silkier over-all appearance than *B. lisae* var. *cuspidatum,* but I am unable to recognize it with certainty by those characters alone.)

Other species of *Bryum* known from the Upper Peninsula:

**Bryum muehlenbeckii** BSG grows on wet rocks near streams in dense, dull, reddish or dark-green tufts tinged with red or brown. It looks rather like a *Pohlia.* The leaves are concave and often cucullate, broad and broadly pointed, with erect margins and a red, percurrent costa. The cells are rhomboidal (3-4:1), with firm, reddish walls; they are narrower in a single marginal row. The plants are dioicous, and the peristome is complete, with well-developed segments and cilia.

**Bryum pallens** (Brid.) Sw. *ex* Roehl. grows in wet places, but not always on rock. It is somewhat like *B. creberrimum* but is dioicous, with spores larger (19-24 $\mu$), leaves more abruptly narrowed to a shorter tip, costa ending in a shorter excurrency, and cells shorter (2-3:1) and laxer.

## 4. **Rhodobryum** (Schimp.) Hampe

Plants fairly robust, dark-green and often red-tinged, gregarious or loosely tufted. Primary stems subterranean, rhizome-like; secondary stems erect, rosulate-foliate, innovating through the rosettes or below them. Leaves remote, small, and scale-like below, much larger and crowded at the stem tips, contorted when dry, wide-spreading at least when moist, oblong-obovate, broadly acute and often abruptly pointed, generally bordered and toothed above; costa strong, very broad below, tapered above, ending slightly below the apex to excurrent as a sharp point; upper cells large and broad, oblong-hexagonal, firm-walled; lower cells elongate-rectangular. Perichaetial leaves smaller, lance-acuminate. Setae 1-3 or more per perichaetium, long, ± hooked or curved at the tip; capsules horizontal to pendent, curved, oblong-cylindric with a short neck, smooth; annulus present; operculum convex and apiculate; peristome double, the 16 teeth lanceolate, yellow- to red-brown below, hyaline at the tips. finely papillose, ± bordered, trabeculate at back; endostome consisting of a high basal membrane, keeled and perforate segments, and nodose to appendiculate cilia.—The generic name translates into the common name, ROSE MOSS, and it refers to a flower-like arrangement of leaves at the tips of the upright stems, and perhaps to red tinges, as well.

**Rhodobryum roseum** (Hedw.) Limpr.—Plants in loose tufts 1-5 cm. high. Upper leaves crowded in a rosette, erect and variously twisted and contorted when dry, wide-spreading when moist, 5-10 mm. long, oblong-obovate, abruptly cuspidate; margins revolute in the lower 2/3, serrate in the upper 1/3-1/2; costa ending in the cuspidate apex or shortly excurrent; upper cells green, oblong-rhomboidal, about 4-6:1, thin- or moderately thick-walled, considerably pitted, 1-2 rows at the margins narrow and yellowish in a ± distinct border. Dioicous. Setae 1-8 from the same perichaetium, 25-40 mm. long; capsules 4-7 mm. long, oblong-cylindric from a short neck, somewhat curved, horizontal to pendent; annulus revoluble; operculum conic, acute; cilia of endostome in 3's and 4's, appendiculate. Spores 15-22 $\mu$, very minutely roughened to finely papillose.—n = 10, 10+1, 11 (and, experimentally, with colchisine, 20).

Conard, How to Know the Mosses, (ed. 2) fig. 147. Darlington, Mosses of Michigan, fig. 76. Grout, Mosses with Hand-lens and Microscope, fig. 116. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 20 (as *R. ontariense*), (ed. 2) Pl. 24. Welch, Mosses of Indiana, fig. 126.–**Fig. 477-479.**

On thin humus or soil over boulders in woods, or sometimes on the forest floor, on logs, or bark at the base of trees. Circumpolar; Newfoundland to Manitoba, south to North Carolina and Akransas; British Columbia and Alberta; Arizona and Mexico.

CHEBOYGAN CO.–Grapevine Point, Reeses Bog, Gorge of Carp Creek, Fontinalis Run, Mud Lake, Ellis Township, Little Lake 16. EMMET CO.– W. Branch of Maple River, Harbor Springs, Five Mile Creek, Middle Village, Big Stone Bay, Cecil Bay. MACKINAC CO.–Bois Blanc Island, Bush Bay, McKays Creek, Ozark. PRESQUE ISLE CO.–Presque Isle lighthouse, Rainy River Falls, Clinton Lake.

A very attractive moss, in many ways similar to a *Mnium,* but actually more nearly related to *Bryum* as evidenced by the elongate leaf cells and rather indistinct border of narrower, yellowish cells. Sporophytes are rare.

It has been suggested by numerous authors (and most recently Iwatsuki & Koponen, Acta Bot. Fenn. 96: 1-22. 1972) that all our material in eastern North America should be referred to *R. ontariense* (Kindb.) Kindb. (although the differences are slight and the ranges greatly overlapping).

**Mielichhoferia mielichhoferi** (Funck *ex* Hook.) Loeske (fig. 480-483), one of the rare copper mosses, has been found at Pictured Rocks along the south shore of Lake Superior. The plants are dioicous, with both male and female inflorescences lateral (at or near the base of stems or at the dichotomies formed by branches); the capsule is erect and symmetric and the peristome single, consisting of endostome only. Information on the biology of the copper mosses is given above in a discussion of *Scopelophila.*

By analyzing rocks and mineral uptake, Coker (Trans. Brit. Bryol. Soc. 6(2): 317-322. 1971) was able to determine the probable origin of Scottish specimens of *Mielichhoferia,* (a copper moss) and *Saelania* (a calciphile) with inadequate collection data.

## MNIACEAE

Plants small or, more often, relatively robust, gregarious to loosely tufted, dull, dark-green or yellow-green, often ± tomentose. Stems erect, simple or forked, rarely dendroid; sterile stems sometimes prostrate, tapered, and somewhat flattened. Leaves small and remote below, larger and more crowded above, often forming a terminal tuft or rosette, usually not greatly contorted when dry, mostly broad, elliptic to obovate, usually broadly pointed and often apiculate, frequently bordered by linear cells and often strongly toothed, the teeth sometimes in pairs; costa single, strong, broad at the base, tapered above, generally ending somewhat below the apex; cells mostly rounded-quadrate or hexagonal, mostly firm- or thick-walled, smooth (or very rarely mammillose), becoming longer and mostly rectangular below. Perigonia discoid, usually with clavate paraphyses; perichaetia bud-like, with small, lanceolate inner bracts and few, filiform paraphyses. Setae terminal, single or clustered, mostly elongate, usually ± hooked at the tips; capsules inclined to pendent, very rarely erect, symmetric or nearly so, oblong-ovoid to cylindric, rarely subglobose, short-necked, smooth; annulus usually present; operculum convex to obliquely rostrate; stomata nearly always immersed, mostly restricted to the neck; peristome double, with 16 lanceolate teeth; endostome typically with a high basal membrane, keeled segments alternating with the teeth, and usually well-developed cilia (in *Orthomnium* the endostome is reduced to a rather low membrane; in *Cinclidium* the endostome is longer than the teeth, and the segments are coalesced at their tips). Spores spherical. Calyptrae mostly cucullate.

Endostome about as long as the exostome, consisting of a high basal membrane, keeled segments, and well-developed cilia; leaves mostly toothed but, if entire, not ending in a long, cuspidate point 1. *Mnium*

Endostome considerably longer than the exostome, consisting of a pleated dome supported by keeled columns alternating with the exostome teeth; leaves entire, abruptly cuspidate 2. *Cinclidium*

## 1. **Mnium** Hedw., *nom. cons.*

Medium-sized to fairly robust plants in light- to dark-green, yellowish, brown, or reddish tufts, often ± tomentose below. Stems simple or forked by innovations, erect (or sometimes sterile stems spreading or prostrate, ± complanate-foliate, and stoloniform-attenuate). Leaves erect- to wide-spreading when moist, generally crisped and contorted when dry, elliptic or oblong-ovate to obovate or nearly rounded, broadly pointed to rounded at the apex and frequently mucronate to cuspidate, usually bordered by linear cells in 1-several layers, entire to strongly toothed, sometimes in pairs; costa ending well below the apex or more often subpercurrent to shortly excurrent; upper cells hexagonal to rounded- or oblong-hexagonal, often thickened at the corners and minutely pitted, smooth, frequently in oblique rows, longer and oblong near the base. Inner perichaetial leaves small and lanceolate. Setae single or clustered, elongate, smooth; capsules suberect to inclined or pendent, oblong-cylindric from a short, usually inconspicuous neck; annulus present; operculum convex-conic, sometimes apiculate to rostrate; stomata mostly immersed and nearly always restricted to the neck; peristome teeth inserted near the mouth, lance-acuminate, yellow or yellow-brown, densely and finely papillose, bordered and trabeculate; endostome yellowish to brown, finely papillose, with a high basal membrane, broad segments perforate and finally gaping along the keels, often with irregular margins, cilia well developed, nodulose, in groups of 2-4. Calyptrae cucullate, smooth, naked.—An ancient Greek name for a moss. *Mnium* is often confused with *Bryum,* perhaps because of similarly nodding capsules. The leaves in *Mnium* are generally broader and variously elliptic to obovate and strongly bordered, the leaf cells are more or less isodiametric rather than oblong-hexagonal in a kind of fish-net pattern, and the capsules are cylindric rather than tapered to the base by way of a well-defined neck.

The genus is a traditional one, and I prefer to retain it as a convenience, even though it can be subdivided on the basis of good structural and cytological differences. Following Koponen (Ann. Bot. Fenn. 5: 117-151. 1968), one could assign our species to the following genera: *Mnium*—with double-toothed leaves (*M. lycopodioides, M. marginatum, M. orthorrhynchum, M. spinulosum,* and *M. stellare*); *Plagiomnium*—with single-toothed leaves (*M. cuspidatum, M. drummondii, M. affine, M. medium,* and *M. longirostrum*); *Rhizomnium*—with entire leaves and a thick cartilaginous border (*M. punctatum* and *M. pseudopunctatum*); and *Pseudobryum*—with entire, scarcely bordered leaves and diagonally elongate cells (*M. cinclidioides*). Koponen's study is one of the few papers on mosses attempting to analyze species relationships on the basis of primitive vs. advanced characters.

Lowry (Mem. Torrey Bot. Club 20, part 2, pp. 1-42. 1948) laid the cytological basis for such a generic separation (using, in the main, Michigan materials) and also showed a haploid-diploid relationship between *M. orthorrhynchum* and *M. marginatum* and also between *M. affine* and *M. medium.* In both pairs of species, the differences are essentially quantitative and sexual, the haploids being smaller in various ways and dioicous, the diploids monoicous (paroicous or synoicous). This raises the interesting possibility of speciation through natural apospory (the production of polyploid, bisexual gametophytes by the regeneration of sporophytic tissue). It is known, of course, that apospory can be induced in many mosses, as demonstrated especially by the well publicized research of the Marchals and Wettstein. (See references following *Physcomitrium,* above.)

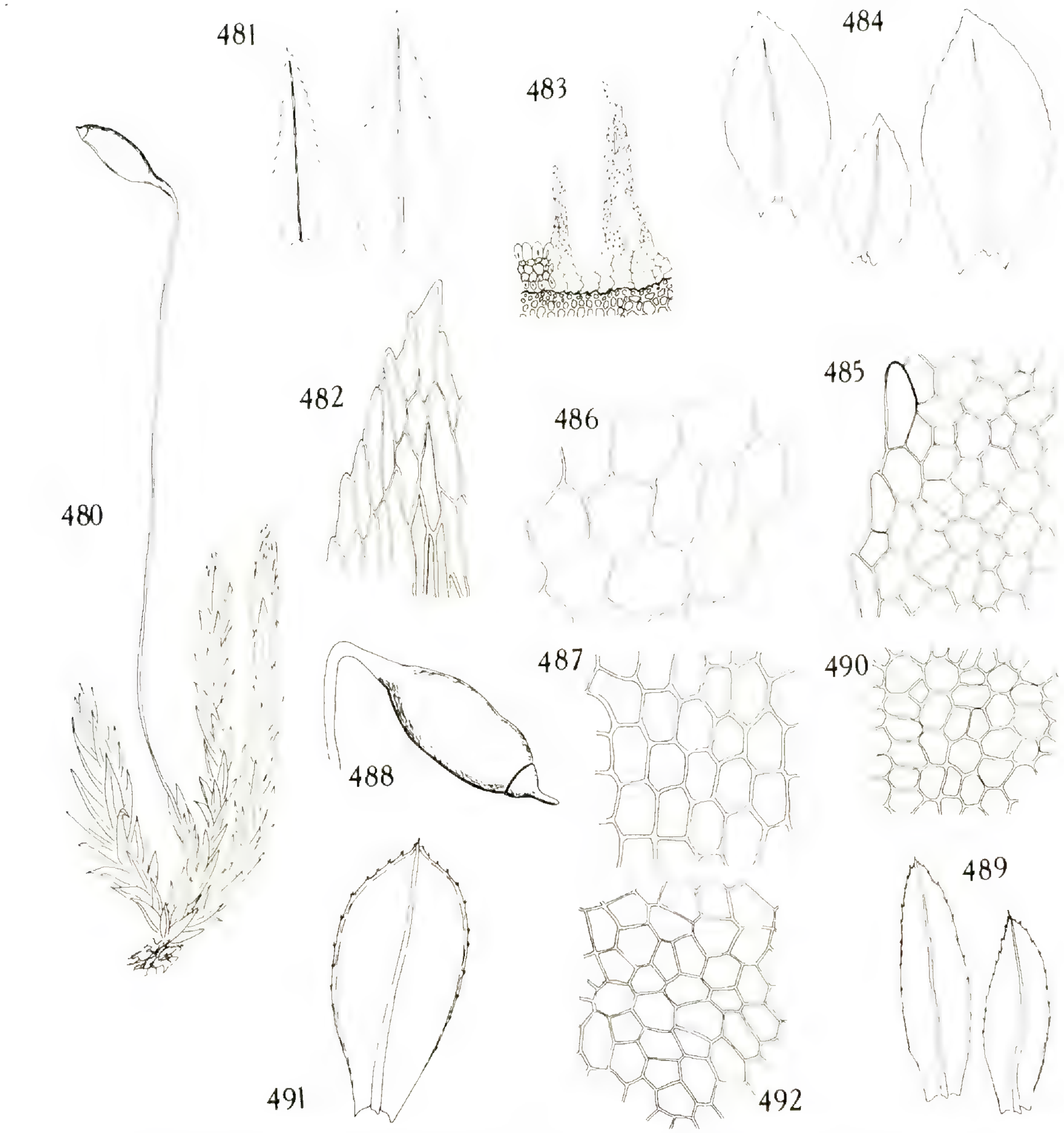
1. Leaves distinctly toothed
 2. Leaf border none or obsolete — 1. *M. stellare*
 2. Leaf border clearly differentiated
  3. Leaves doubly serrate
   4. Dioicous
    5. Upper cells firm-walled, only slightly thickened at the corners — 4. *M. orthorrhynchum*
    5. Upper cells with delicate, pellucid walls clearly thickened at the corners — 2. *M. lycopodioides*
   4. Paroicous (and sometimes synoicous)
    6. Upper leaf cells hexagonal, with thin walls not thickened at the corners; setae often in 2's and 3's — 5. *M. spinulosum*
    6. Upper cells rounded-hexagonal or subquadrate, with firm walls thickened at the corners; setae single — 3. *M. marginatum*
  3. Leaves singly serrate
   7. Leaves toothed only in the upper half
    8. Cells 14-26 $\mu$, irregularly rounded-hexagonal, with rather thick walls thickened at the corners; setae single — 6. *M. cuspidatum*
    8. Cells 25-50 $\mu$, hexagonal, with thin or firm walls not thickened at the corners; setae generally in groups of 2-4 — 7. *M. drummondii*
   7. Leaves toothed nearly to the base
    9. Dioicous — 8. *M. affine*
    9. Synoicous (or sometimes paroicous)
     10. Operculum ± apiculate; stomata restricted to the neck; leaves cuspidate from a rounded-obtuse apex, sharply toothed; upper leaf cells 28-55(77) $\mu$ — 9. *M. medium*
     10. Operculum long-rostrate; stomata scattered over much of the capsule; leaves cuspidate from a rounded-obtuse to truncate or emarginate apex, bluntly and minutely toothed; upper cells 22-44 $\mu$ — 10. *M. longirostrum*
1. Leaves entire (or very indistinctly toothed)
 11. Leaves obscurely bordered by somewhat narrower cells in 3-4 marginal rows, obscurely serrulate; upper cells elongate, in oblique rows — 11. *M. cinclidioides*
 11. Leaves distinctly bordered by linear cells, entire; upper cells not elongate or in oblique rows
  12. Dioicous — 12. *M. punctatum*
  12. Synoicous — 13. *M. pseudopunctatum*

1. **Mnium stellare** Hedw.—Rather small plants in loose, dark-green or red-brown tufts up to 2 or 3, sometimes 5 cm. high, somewhat radiculose below. Stems erect or ascending, dark-red at least below. Leaves loosely erect or spreading, somewhat wavy or irregularly curved when dry, 1.5-2.5 mm. long, elliptic or ovate-elliptic, obtuse and often abruptly short-pointed, decurrent, not or very indistinctly bordered, the upper leaves irregularly denticulate toward the apex because of broad, unicellular teeth mostly projecting at an angle on both surfaces, sometimes nearly paired; costa ending well below the apex, brown or reddish; upper cells irregular in size and shape, 15-30 $\mu$, hexagonal or rounded- to quadrate-hexagonal, with thin or slightly thickened walls somewhat thickened at the corners, 1-2 marginal rows sometimes slightly longer and not or somewhat darker. Dioicous. Setae 10-20 mm. long, single, reddish; capsules 2-3 mm. long, oblong-cylindric from a short neck, pendulous to pendent, pale- to dark-brown, darker at the neck; peristome teeth yellow-brown; endostome golden-brown, with cilia in groups of 2-4. Spores 20-29 $\mu$, very finely papillose.—n = 6+1, 7.

Conard, How to Know the Mosses, (ed. 2) fig. 157. Grout, Mosses with Hand-lens and Microscope, fig. 121. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 22, (ed. 2) Pl. 26. Welch, Mosses of Indiana, fig. 127.—**Fig. 484-485.**

On soil, humus, logs, and rock but most often on the bases of trees and stumps, in wet woods. Europe and Asia; Nova Scotia to Saskatchewan, south to North Carolina and Arkansas.

CHEBOYGAN CO.—Reeses Bog, Gorge of Carp Creek, Iron Bridge, Mill Creek, Mud Lake. EMMET CO.—Larks Lake, Pleasantview Swamp, Middle Village, Wycamp Lake, Sturgeon Bay. MACKINAC CO.—Mackinac Island, Castle Rock, Ozark. PRESQUE ISLE CO.—Rainy River Falls.




*Mielichhoferia mielichhoferi.* 480. Habit. 481. Leaves. 482. Upper cells of leaf. 483. Portion of peristome.

*Mnium stellare.* 484. Leaves. 485. Upper cells at margin of leaf.

*Mnium lycopodioides.* 486. Upper cells of leaf.

*Mnium marginatum.* 487. Upper cells of leaf. 488. Capsule.

*Mnium orthorrhynchum.* 489. Leaves. 490. Upper cells of leaf.

*Mnium spinulosum.* 491. Leaf. 492. Upper cells of leaf.

*Mnium stellare* is easily recognized with a hand-lens by the virtual absence of a leaf border and the costa ending well below the apex.

2. **Mnium lycopodioides** Schwaegr.—Relatively slender plants in loose, light- or dark-green tufts 1-4.5 cm. high, somewhat radiculose below. Stems reddish. Leaves twisted and contorted when dry, erect-spreading when moist, 3-4, rarely 6.5 mm. long, lanceolate or ovate-lanceolate, acute and ± apiculate, decurrent, with a thickened border of linear, pellucid cells, doubly serrate; costa reddish, percurrent or confluent

with the border to form an apiculus, generally toothed at back above; cells irregularly rounded-hexagonal, with thin, delicate, and usually hyaline walls somewhat thickened at the corners, 17-24 (occasionally 30) $\mu$. Dioicous. Setae single, orange-red, 15-40 mm. long, capsules nearly horizontal or somewhat pendulous, 2.5-5.5 mm. long, oblong-cylindric from a short neck, yellow-brown; operculum stoutly and obliquely rostrate; stomata immersed, in the neck; peristome teeth greenish-yellow; endostome yellow-brown, with perforate segments and cilia in 3's. Spores finely papillose, 19-29 $\mu$. Calyptrae brown, smooth.—n = 6.

Grout, Moss Flora of North America 2: Pl. 104A, 105 (fig. 3).—**Fig. 486.**

On damp, shaded soil or rock, often on cliffs, also on humus and rotten logs. Circumpolar; British Columbia and Alberta to Oregon and Montana; Nova Scotia to Manitoba, south to Kentucky and Michigan.

CHEBOYGAN CO.—Douglas Lake.

The delicate leaf cells with hyaline walls somewhat thickened at the corners are distinctive.

2. **Mnium marginatum** (With.) Brid. *ex* P.-Beauv.—Relatively slender plants in loose, green or brownish tufts 1-3, sometimes 4 cm. high, somewhat radiculose below. Stems reddish. Leaves crisped and contorted when dry, erect-spreading when moist, 2-4.5 mm. long, elliptic or oblong-ovate, acute and long-apiculate, decurrent, with a thickened border of linear, usually reddish cells, doubly serrate at least near the apex (the teeth often reduced, sometimes nearly lacking); costa subpercurrent or, more often, confluent with the border to form the apiculus, reddish, not toothed at back; upper cells 24-30, rarely 38 $\mu$, hexagonal or shortly oblong-hexagonal, with firm, usually pale-brown walls thickened at the corners, often in longitudinal rows. Paroicous or occasionally synoicous. Setae single, orange-yellow or reddish at least below, 13-25 mm. long; capsules 1.5-3.5 mm. long, oblong-cylindric from a short neck, yellow-brown, nearly horizontal to pendulous; operculum stoutly and obliquely rostrate; stomata immersed, in the neck; exostome teeth brownish or golden-brown; endostome golden-brown or brown, with segments perforate and cilia mostly in 3's but sometimes in 2's or 4's. Spores 22-32 $\mu$, finely papillose. Calyptrae brown, smooth.—n = 12.

Darlington, Mosses of Michigan, fig. 77 (as *M. serratum*). Grout, Mosses with Hand-lens and Microscope, Pl. 51 above (as *M. serratum*), Moss Flora of North America 2: 105 (fig. 1). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 21 and (ed. 2) Pl. 25 (as *M. serratum*). Welch, Mosses of Indiana, fig. 128 (as *M. serratum*).—**Fig. 487-488.**

On soil or rock in moist, shady places, particularly on banks of streams or on cliffs. Circumpolar; Mexico and Guatemala; Falkland Islands; Alaska to Arizona and New Mexico; Manitoba and New Brunswick to Arkansas and North Carolina.

CHEBOYGAN CO.—Reeses Bog, Mill Creek. EMMET CO.—Maple River, Wilderness State Park. MACKINAC CO.—Bois Blanc Island, Ozark.

This species and the next are distinguished by sex, cell size, and chromosome number, *M. marginatum* being a diploid, *M. orthorrhynchum* a haploid. *M. marginatum* is paroicous (or rarely synoicous), and its leaf cells, 24-30 $\mu$, or more, are generally arranged in longitudinal rows.

4. **Mnium orthorrhynchum** Brid.—Plants rather small and slender, in loose tufts about 10-20, occasionally as much as 70 cm. high, green with reddish tinges. Leaves

erect-spreading, ± wavy and twisted when dry, 2-3, sometimes 4.5 mm. long, oblong-ovate, acute to short-apiculate, decurrent, bordered by linear cells in more than 1 layer, doubly serrate; costa nearly always confluent with the border to form the apiculus, not or slightly toothed at back near the tip, reddish; upper cells 15-22 $\mu$, hexagonal, firm-walled, somewhat thickened at the corners. Dioicous. Setae single, 13-18 mm. long, reddish; capsules nearly horizontal to pendulous, relatively long and slender, cylindric, 2-4 mm. long, abruptly contracted to a short neck; operculum obliquely rostrate, 1-1.5 mm. long; stomata immersed, in the neck; exostome teeth greenish-yellow; endostome brown, with perforate segments and cilia in 2's. Spores 20-31 $\mu$, very finely roughened. Calyptrae brown, smooth.–n = 6, 8.

Grout, Mosses with Hand-lens and Microscope, Pl. 51 below, Moss Flora of North America 2: Pl. 105 (fig. 2).–**Fig. 489-490.**

On damp, shaded rock, soil, humus, and bark at base of trees, common on stream banks or cliffs. Circumpolar; Greenland to Alaska, south to North Carolina, Arkansas, New Mexico, Arizona, and California.

CHEBOYGAN CO.–Douglas Lake, Reeses Bog, Hermits Bog, Iron Bridge, Burt Lake, Mill Creek. EMMET CO.–Maple River, Cross Village, Wycamp Creek, Big Stone Bay. MACKINAC CO.–Mackinac Island, McKays Creek, Ozark, Caffey Corner. PRESQUE ISLE CO.–Ocqueoc River.

Best recognized by the small cells (less than 24 $\mu$) and dioicous inflorescence.

5. **Mnium spinulosum** BSG–Plants in loose, deep-green tufts tinged with red, 0.5-1 or sometimes 2.5 cm. high, radiculose only at base. Stems becoming red. Leaves erect, only slightly contorted when dry, 2.5-3.5 (or sometimes 4.5) cm. long, broadly obovate, cuspidate, decurrent, strongly bordered, the border thick and rounded in section, red or brown, sharply double-serrate in the upper half or somewhat more; costa shortly excurrent, brown or red, not toothed at back; cells 21-25, rarely 35 $\mu$, irregularly hexagonal, with thin walls not thickened at the corners. Paroicous. Setae single, paired, or sometimes in 3's, 8-35 mm. long, red-yellow; capsules 1.5-3 mm. long, oblong-cylindric, short-necked, horizontal to pendulous, brownish, dark red-brown at the mouth; operculum obliquely rostrate from a convex-conic base; stomata immersed, in the neck; peristome teeth dark, red-brown; endostome light- or golden-brown, with cilia sometimes single but usually in 2's and 3's. Spores 18-21 $\mu$, finely papillose.–n = 8.

Grout, Mosses with Hand-lens and Microscope, fig. 118f-h. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 65.–**Fig. 491-492.**

On humus, soil, logs, and rocks in coniferous forests. Circumpolar; Nova Scotia to Alaska, south to Maryland, the Great Lakes, Colorado, and Oregon.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Douglas Lake, Livingston Bog, Mud Lake, Grass Bay. EMMET CO.–Arnott Lake, Sherett Lake, Pleasantview Swamp, Pellston Hardwoods, Carp Lake, Cross Village, Big Stone Bay, Conway Bog, Ramona Beach. MACKINAC CO.–Mackinac Island, Bois Blanc Island, Castle Rock, McKays Creek, Cut River, Ozark, Little Dollar Lake, McNamara Pond. PRESQUE ISLE CO.–Mast Point, Kelsey Pond.

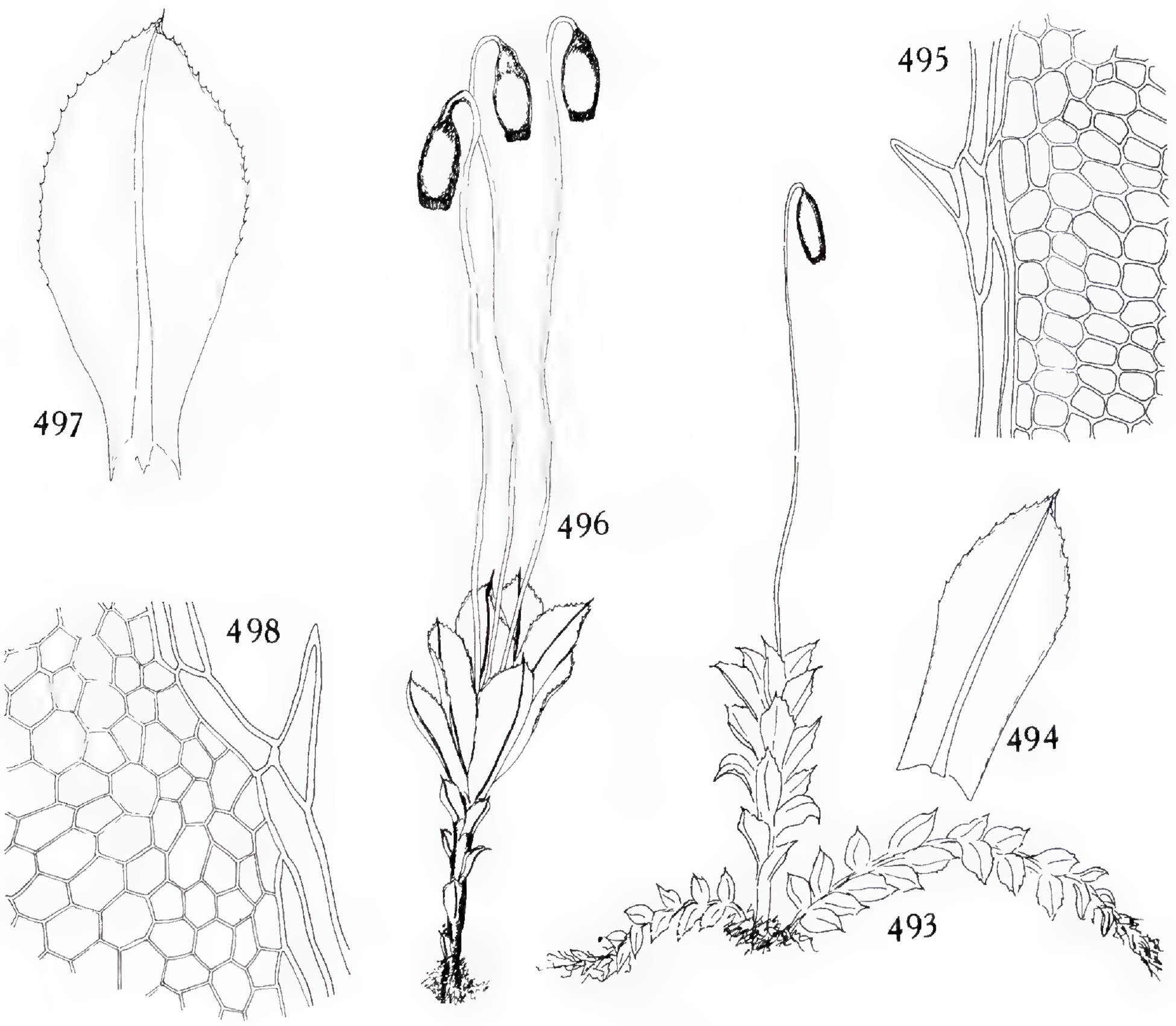
Grout called this the RED-MOUTHED MNIUM, and it has been called the FLAPPER MOSS in allusion to the same feature. The species is recognized by its dark-green leaves which are broad for the double-toothed group, as well as its red peristome.

6. **Mnium cuspidatum** Hedw.—Plants in dark- or yellow-green, loose, often extensive tufts up to 2 or 3.5 cm. high, somewhat radiculose below. Stems green, the sterile ones spreading or horizontal, often stoloniform-attenuate, ± complanate-foliate. Leaves erect or erect-spreading, strongly crisped and contorted when dry, about 3-4.5 mm. long, obovate, acute to cuspidate-acuminate, decurrent, bordered by 2-4 rows of linear cells in 1 layer, with single, sharp, unicellular teeth in the upper half; costa percurrent or shortly excurrent, greenish; upper cells irregularly rounded-hexagonal, rather thick-walled and ± thickened at the corners, 14-26 $\mu$. Synoicous. Setae single, 10-30 mm. long, yellowish or brownish; capsules 2-3 mm. long, pendent, yellowish or brownish; operculum convex-conic; stomata immersed, in the neck; peristome teeth yellow; endostome brown, the basal membrane fenestrate, cilia in groups of 2-4. Spores 24-31 $\mu$, finely papillose.—n = 6, 12.

Grout, Mosses with Hand-lens and Microscope, fig. 117e-f (as *M. sylvaticum*), Moss Flora of North America 2: Pl. 101D. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 21, (ed. 2) Pl. 25. Welch, Mosses of Indiana, fig. 129.—**Fig. 493-495.**

On soil and humus, particularly on wooded banks, also on logs, stumps, bases of trees, or rock, in moist woods. Circumpolar; Labrador to Alaska, south to Oregon and Arizona, throughout eastern North America

CHEBOYGAN CO.—Reeses Bog, Pine Point, near Smiths Bog, Ingleside, Colonial Point, Livingston Bog, Mud Lake, Duncan Bay. EMMET CO.—Pellston Hills, Levering, Carp Lake, Wycamp




*Mnium cuspidatum.* 493. Habit. 494. Leaf. 495. Upper cells at margin of leaf.
*Mnium drummondii.* 496. Habit. 497. Leaf. 498. Upper cells at margin of leaf.

Lake, Middle Village, Five Mile Creek. MACKINAC CO.–Bois Blanc Island, Mackinac Island, McKays Creek, Prentiss Bay, Gros Cap, Cut River, Ozark. PRESQUE ISLE CO.–Hammond Bay, Mast Point, Ocqueoc River Falls.

*Mnium cuspidatum* is one of the most common mosses in eastern North America, characteristic of moist hardwood forests but also found in many other habitats, in poor lawns and in drainage channels on roadside maple trees or in their crotches, for example. It is often called the WOODSY MNIUM (translating a synonym formerly in usage, *M. sylvaticum*). It is recognized by obovate leaves, crisped when dry, and toothed only above the middle. In a sterile condition it consists of spreading stolons with leaves loosely arranged in two rows. The relatively small, rounded-hexagonal leaf cells are rather thick-walled and more or less thickened at the corners.

7. **Mnium drummondii** Bruch & Schimp.–Plants in loose, light-green or yellowish tufts 2-3 or sometimes 5 cm. high, radiculose below. Stems green to brownish, the sterile ones spreading, somewhat stoloniform-attenuate and ± complanate-foliate. Leaves loosely erect or erect-spreading, not much contorted when dry, 4-6 mm. long, broadly obovate, cuspidate-acuminate, decurrent, bordered by 2-3 rows of linear cells in 1 layer, with single, sharp, mostly unicellular teeth in the upper half; costa greenish, subpercurrent to shortly excurrent; upper cells 25-50 $\mu$, hexagonal with straight, thin or rather firm walls, not at all thickened at the corners. Synoicous (rarely also producing a large terminal perigonium with differentiated bracts). Setae 1-3 from the same perichaetium, 12-28 mm. long, yellow or orange-yellow; capsules 2-3 mm. long, pale-yellow, pendulous to pendent; operculum convex-conic; stomata superficial, in the neck; exostome yellow or greenish-yellow; endostome brown, the cilia in groups of 2-3. Spores 18-24 $\mu$, finely papillose.–n = 6.

Grout, Moss Flora of North America 2: Pl. 100 right, 101C.–**Fig. 496-498.**

On soil, humus, bark at base of trees, and rocks in woods. Circumpolar; British Columbia to Nova Scotia and south to Maryland, Michigan, Minnesota, and Washington.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge (Carp Creek). EMMET CO.–Levering. MACKINAC CO.–Mackinac Island.

A rare species rather similar to the *M. cuspidatum,* recognized by clustered sporophytes, leaves scarcely contorted when dry, and cells larger and more regularly hexagonal, with thin walls not thickened at the corners.

8. **Mnium affine** Bland. *ex* Funck, *sensu lato*–Plants in green or yellow-green, loose or dense tufts about 3-9 cm. high, usually brown-tomentose below. Sterile stems spreading to deflexed, often elongate. Leaves erect or spreading and strongly contorted when dry, spreading when moist, 5-8 mm. long, elliptic to oblong-obovate, broadly acute to rounded-obtuse, abruptly cuspidate-pointed, decurrent, bordered by 2-4 rows of linear cells in 1 layer, toothed nearly to the base by teeth of 1-3 cells (or the teeth often short and blunt and sometimes nearly lacking); costa excurrent as a cuspidate point; upper median cells nearly hexagonal or more often oblong-hexagonal in oblique rows, 22-35 × 33-65 $\mu$, thin- or moderately thick-walled, inconspicuously pitted and somewhat thickened at the corners. Dioicous. Setae single (or rarely in 2's or 3's), 18-50 mm. long, yellowish above, reddish below; capsules pendulous, oblong-cylindric, 3-5 mm. long, brown or brownish-yellow; operculum apiculate; stomata somewhat immersed, in the short and inconspicuous neck; exostome teeth yellowish; endostome brown, the basal membrane not or slightly perforate, segments broadly fenestrate,

appendiculate at the apex, cilia in groups of 2-4. Spores 26-29 $\mu$, minutely papillose.—n = 6 (also as var. *ciliare,* n = 6, and as var. *rugicum,* n = 6).

Breen, Mosses of Florida, Pl. 67 (figs. 1-3). Grout, Mosses with Hand-lens and Microscope, Pl. 49 and fig. 117a-c (as var. *ciliare*), g, Moss Flora of North America 2: Pl. 101A. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 22 & (ed. 2) Pl. 26 (as var. *ciliare* and var. *rugicum*). Welch, Mosses of Indiana, fig. 131.—**Fig. 499-501** (var. *ciliare*).

On wet soil, humus, and rotten wood, in swampy woods, frequently among willows and other shrubs along small streams. Circumpolar; South America; Greenland to Alaska and south to California, Wyoming, Texas, and Florida.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Livingston Bog, Colonial Point, Mud Lake, Grass Bay, Little Lake 16. EMMET CO.—Pellston Hills, Pleasantview Swamp, Cross Village, Five Mile Creek, Conway Bog. MACKINAC CO.—Mackinac Island, Cut River, Hendricks, McNamara Pond. PRESQUE ISLE CO.—Lamprey Experiment Station, Evergreen Beach, Presque Isle lighthouse, Clinton Lake.

*Mnium affine* is an Old World species represented in North America by the var. **ciliare** C. M. (leaves broadly decurrent; marginal teeth distinct and often very long, consisting of 1-4 cells; setae single) and var. **rugicum** (Laur.) BSG (leaves not decurrent; marginal teeth short, of 1-2 cells but usually reduced and often nearly lacking; setae clustered). The var. *rugicum* is usually sterile and poorly developed and even at best difficult to separate from depauperate expressions of var. *ciliare.* The differences between the var. *ciliare* and the var. *affine* are small indeed. In the var. **affine**, the setae are clustered and the leaves narrowly decurrent. Such differences assume some importance, however, because of geographic separation: The var. *affine* occurs in Europe and the Caucasus; the var. *ciliare* is limited to North America; and the var. *rugicum* is circumpolar.

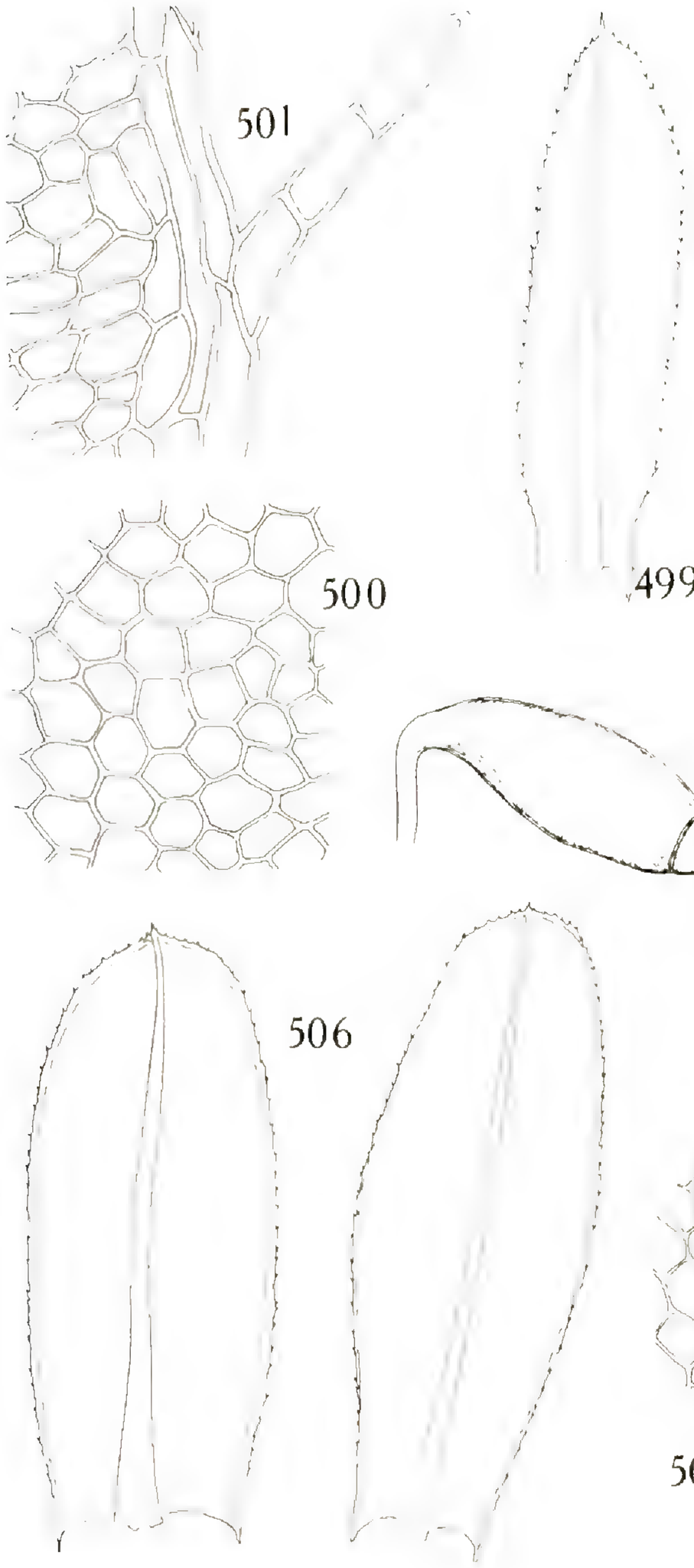
We have both var. *ciliare* and var. *rugicum* in the Douglas Lake region. They are somewhat similar to *M. cuspidatum,* which is synoicous and has marginal teeth only in the upper half of leaves. *Mnium medium* is even closer in appearance and relationship, differing mainly in the synoicous inflorescence and larger size. The leaves are broadly decurrent and distinctly toothed all around, but the teeth are much shorter than those of *M. affine* var. *ciliare.*

The var. *rugicum,* like the var. *affine,* grows in wet, eutrophic habitats, especially in thickets along streams, the var. *ciliare* in mesic situations in deciduous or mixed woods.

9. **Mnium medium** BSG—Plants in loose, light- or yellow-green tufts about 2.5-7 cm. high, tomentose. Stems greenish; sterile stems few, spreading or deflexed, not much elongate. Leaves erect-spreading or spreading when moist, wide-spreading and strongly crisped and contorted when dry, 5-10 mm. long, elliptic to oblong-obovate, rounded-obtuse and abruptly short-cuspidate, decurrent, bordered by 2-4 rows of linear cells in 1 layer, with single, rather sharp, unicellular teeth nearly to the base; costa shortly excurrent; upper cells 28-55 (and sometimes up to 77) $\mu$, irregularly rounded- and oblong-hexagonal, with firm or rather thick walls, thickened at the corners, pitted. Synoicous and paroicous. Setae 1-3 (sometimes 7) from the same perichaetum, 20-45 mm. long, pale-yellow, becoming red or orange-red with age; capsules 3-4 mm. long, brown, pendulous or pendent; operculum convex-conic, ± apiculate; stomata immersed, in the neck; peristome teeth yellow or brownish; endostome brown, the cilia in groups of 2-4. Spores 24-29 $\mu$, finely papillose.—n = 12.

Grout, Moss Flora of North America 2: Pl. 101 above, 101B. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 21, (ed. 2) Pl. 25. Welch, Mosses of Indiana, fig. 130.—**Fig. 502-505.**

On soil, humus, rock, and bases of trees in wet woods. Circumpolar; Greenland to Alaska, south to California, Arizona, Colorado, Arkansas, and Maryland.



*Mnium affine* var. *ciliare*. 499. Leaf. 500. Upper cells of leaf. 501. Marginal tooth.
*Mnium medium*. 502. Habit. 503. Leaf. 504. Upper cells of leaf. 505. Capsule.
*Mnium longirostrum*. 506. Leaves. 507. Leaf cells. 508. Capsule.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge (Carp Creek), Colonial Point, Ellis Township, Douglas Lake, Mud Lake. EMMET CO.–Wycamp Lake, Cross Village. MACKINAC CO.–Mackinac Island, McKays Creek, Cut River, Epoufette.

*Mnium medium* has a somewhat distinctive appearance based largely on size and defying description, although the clustered sporophytes generally give a clue to its identity. The species is related to *M. affine,* differing essentially in size, sex, and chromosome number (being a diploid).

10. **Mnium longirostrum** Brid.–Plants in light or dark-green tufts about 2-4 cm. high, brown-radiculose below. Stems greenish; sterile stems numerous, deflexed to horizontal, up to 5 or 6 cm. long, with rather distant, ± 2-ranked leaves. Leaves larger and ± crowded at the stem tips, spreading, recurved and strongly contorted when dry, 4-7 mm. long, elliptic, rounded-obtuse or emarginate and abruptly mucronate to

cuspidate, slightly decurrent, strongly bordered by 3-5 rows of linear cells in 1 layer, serrulate all around by small and inconspicuous, blunt teeth of 1 cell; costa subpercurrent to shortly excurrent; upper cells 22-24 $\mu$, irregularly oblong-hexagonal, in oblique rows, firm- or fairly thick-walled, pitted, thickened at the corners. Synoicous. Setae 1-4 per perichaetium (often 5-7 in tropical America), yellow, becoming orange or red, 15-35 mm. long; capsules 2.5-3 mm. long, oblong, pendulous, yellow-brown; operculum obliquely long-rostrate; stomata immersed, scattered over much of the capsule; exostome teeth yellowish; endostome golden-brown or brown, with perforate segments and cilia in groups of 2-4. Spores 22-33 $\mu$, very finely roughened. Calyptrae pale-brownish, smooth.—n = 7, 7(6+x/y), 12, 14, 21.

Breen, Mosses of Florida, Pl. 66 (fig. 1-3). Grout, Mosses with Hand-lens and Microscope, Pl. 50 (as *M. rostratum*).—**Fig. 506-508.**

On damp, shaded rock and soil. Nearly cosmopolitan; widely scattered but uncommon in North America, from British Columbia and Alberta to Oregon and Colorado, also southeastern Canada to the Gulf of Mexico.

MACKINAC CO.—Mackinac Island.

*Mnium longirostrum* can be recognized by its elliptic leaves which are more or less rounded to truncate or emarginate at the apex and abruptly short-apiculate. Other useful taxonomic features include the collenchymatous leaf cells, rostrate opercula, and stomata distributed over most of the capsule. (The single record from our area may be a result of mislabeling. I would be more inclined to accept a record from the montane habitats of the Lake Superior region.)

11. **Mnium cinclidioides** Hüb.—Plants in loose, green, or yellowish tufts about 5-7, sometimes 15 cm. high, somewhat shiny when dry, moderately radiculose below. Leaves rather distant, erect or erect-spreading, somewhat contorted when dry, usually about 6-7 mm. long (rarely only 3 mm.), elliptic, rounded or rounded-obtuse and shortly and bluntly apiculate, not decurrent; margins slightly and bluntly serrulate all around; costa ending somewhat below the apex; upper cells large, elongate in oblique rows, about 3-4:1, with walls thin or moderately thickened, pitted, not thickened at the corners, gradually narrowed in 3-4 marginal rows in a suggestion of a border. Dioicous. Setae single (or rarely paired), slender and flexuose, orange-yellow, 20-55 mm. long; capsules 2-3 mm. long, yellow, becoming brown with age, dark and brownish at the mouth, pendent; operculum convex-conic, apiculate; stomata completely immersed, in the neck; peristome teeth dark-brown; endostome yellow-brown, with ± coalesced cilia in groups of 2-4. Spores 31-40 $\mu$, finely papillose.—n = 6, 7.

Grout, Mosses with Hand-lens and Microscope, fig. 120. Jennings, Mosses of Western Pennsylvania (ed. 1) Pl. 23, (ed. 2) Pl. 27.—**Fig. 509-510.**

On wet soil or humus, often in swampy depressions or dried-up pools in mixed woods or hardwood swamps. Circumpolar; Greenland to Alaska and south to New Jersey, Michigan, and Montana.

CHEBOYGAN CO.—Burt Lake (at mouth of Carp Creek), Iron Bridge (Carp Creek). EMMET CO —Larks Lake.

This rare species of wet habitats is somewhat similar to *M. punctatum* but distinguished by the blackish color of the interior of the tufts, large, broad leaves without a distinct border, and leaf cells elongate in diagonal rows.

12. **Mnium punctatum** Hedw.—Plants in loose, pale- to dark-green, often red-tinged tufts, usually less than 5 but sometimes as much as 12 cm. high, often tomentose. Leaves erect or spreading and moderately contorted when dry, spreading when moist, 3.5-9 mm. long (but usually about 6 or 7 mm. long), elliptic or obovate from a narrow base, broadly rounded to emarginate and usually ending in a short, blunt mucro, entire, strongly bordered by linear, often reddish cells usually in several layers; costa usually confluent with the border to form the mucro but often ending somewhat below the apex; upper cells irregularly hexagonal to oblong-hexagonal, sometimes elongate in oblique rows, 1-3:1, 50-100 (rarely 150) × 35-50 $\mu$, thin-walled to fairly thick-walled, pitted. Dioicous. Setae single (or rarely paired), becoming reddish, with a very short neck, yellowish or brownish, horizontal to pendulous; annulus persistent; operculum stoutly rostrate; stomata completely immersed, in the neck; peristome teeth yellowish or brownish-yellow; endostome brown, with cilia cohering, in 2's or 3's. Spores 29-41 $\mu$, finely papillose.—n = 6+1, 6+x/y, 7; 2n = 14.

Grout, Mosses with Hand-lens and Microscope, fig. 118a-e (including var. *elatum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 23 & (ed. 2) Pl. 27 (including var. *elatum*). Welch, Mosses of Indiana, fig. 132.—**Fig. 511-513.**

On wet soil, humus, rotten logs, and rocks in swampy woods, especially along brooks and near springs. Circumpolar; Greenland to Alaska, south to Georgia, Arkansas, Colorado, and California.

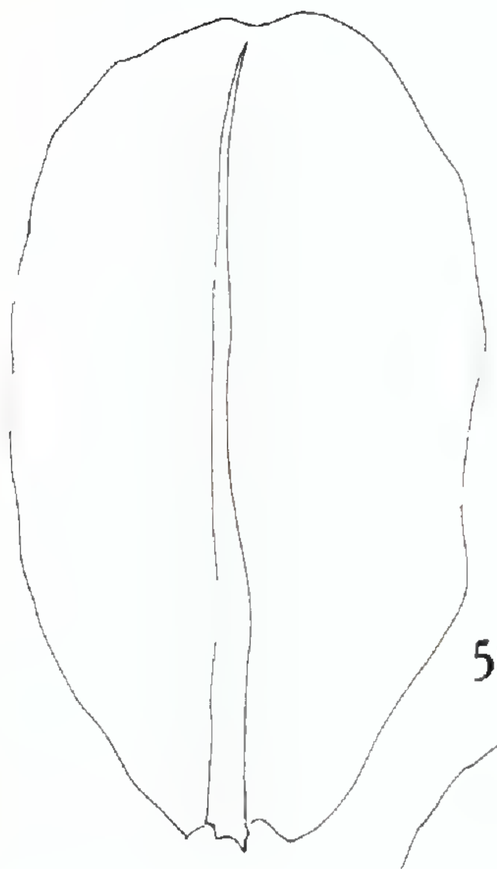
CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Iron Bridge, Gorge of Carp Creek, Livingston Bog, Grass Bay. EMMET CO.—Levering, Maple River, Pleasantview Swamp, Wycamp Lake, Conway Bog. MACKINAC CO.—Bois Blanc Island, Cut River, Epoufette. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Kelsey Pond, Hendricks.

A common species of wet habitats (especially *Thuja* swamps), characterized by broad, emarginate leaves ending in a short, stout apiculus formed by the confluence of costa and heavy, cartilaginous border. (It is likely to be confused with *M. pseudo-punctatum,* which is synoicous and has a shorter costa.)

The male inflorescence has a daisy-like beauty. The specific epithet means dotted and refers to a dark cluster of antheridia surrounded by petal-like leaves. Such a discoid perigonium forms a splash cup conferring possible advantage in the dispersal of sperms.

The var. **elatum** Schimp. is a luxuriant form of particularly wet habitats. In its best expression it is large and handsome with large leaves, without an apiculus and with the costa ending below the apex. It is locally common.—n = 7.

13. **Mnium pseudopunctatum** Bruch & Schimp.—Dark-green plants in rather loose, tomentose tufts about 4-6 cm. high. Leaves erect or erect-spreading and moderately contorted when dry, spreading when moist, 4.5-6 mm. long, nearly rounded to broadly obovate, rounded or slightly retuse at the apex; margins entire, bordered by 1-3 rows of cells, the border unistratose above, somewhat thickened but scarcely cartilaginous below; costa usually ending well below the apex (by about 2-14 cells), often indistinctly forked at the tip; upper cells oblong-hexagonal, elongate in oblique rows, about 45-90 × 27-38 $\mu$, mostly about 1.5-2:1, with relatively thick, pitted walls. Synoicous. Setae single, 13-45 mm. long, orange-brown or reddish; capsules 2-2.3 mm. long, pendent, narrowly ellipsoidal, pale-brown, darker at the short neck and at the mouth; annulus of 2 rows of cells; operculum stoutly and obliquely rostrate; stomata immersed, in the neck; peristome teeth dark-brown, densely papillose below, vertically



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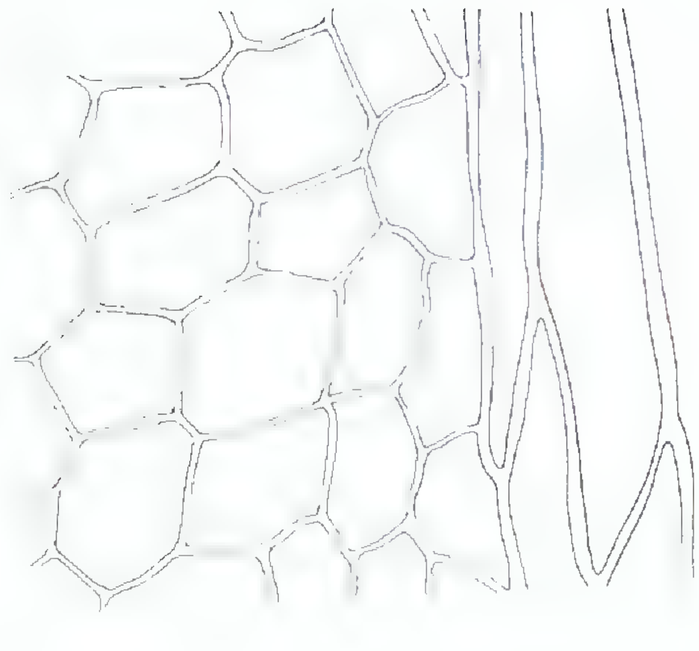

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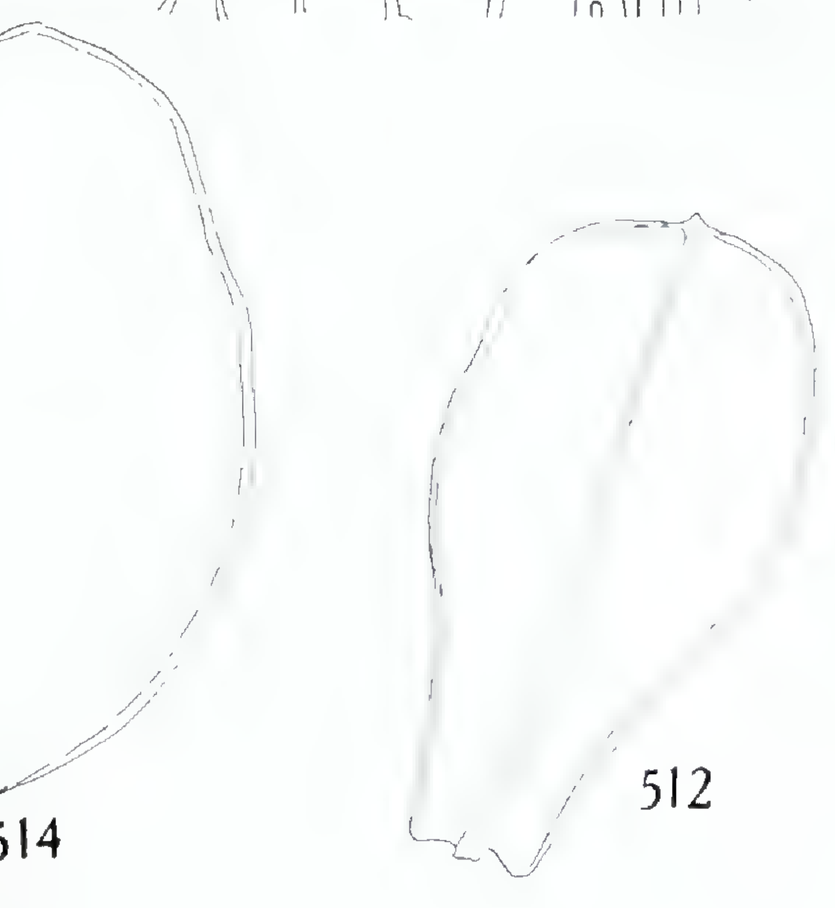

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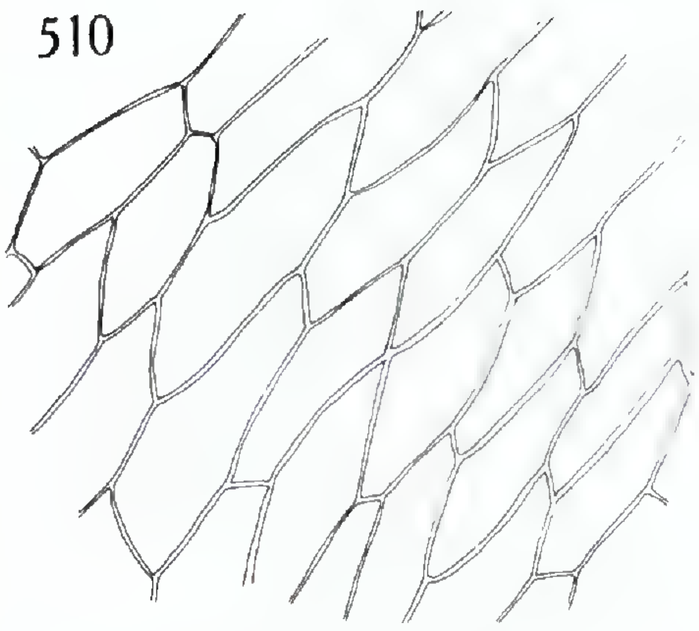

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512

*Mnium cinclidioides.* 509. Leaves. 510. Upper cells of leaf.
*Mnium punctatum.* 511. Habit. 512. Leaf. 513. Cells at apex of leaf.
*Mnium pseudopunctatum.* 514. Leaf. 515. Upper cells of leaf.

striate and papillose above; endostome brownish, with cilia in 3's. Spores 28-48 $\mu$, densely and finely papillose.—n = 13, 14.

**Fig. 514-515.**

On soil and humus in wet places, particularly in fens and wooded swamps, such as *Thuja* bogs, probably a calciphile. Circumpolar; Greenland to Alaska, south to Colorado, the Great Lakes, and Maine.

CHEBOYGAN CO.—Reeses Bog, Mud Lake. EMMET CO.—Maple River, Arnott Lake, Wycamp Lake, Cecil Bay, Conway Bog. MACKINAC CO.—Macckinac Island. PRESQUE ISLE CO.—Lamprey Experiment Station, Evergreen Beach, Clinton Lake.

Distinguished from the much more common *M. punctatum* by the synoicous inflorescence and costa usually ending well below the leaf apex. **M. andrewsianum** Steere, a rare and local species distributed across Siberia and northern North America, has been found in the Lake Superior region of Ontario (Red Rock) and Michigan (Alger Co.). It grows in boggy habitats and is similar to *M. punctatum* and *M. pseudopunctatum.* It is dioicous with leaves only 1-2 mm. long, not mucronate, with an unistratose border and with the costa ending far below the apex.

## 2. **Cinclidium** Sw.

Fairly robust plants in bright-green to red-brown tufts, shiny and translucent (or dewey-looking) when growing, often brown or blackish and matted with brown radicles below. Stems simple or forked. Leaves erect, spreading, or recurved, oval or broadly obovate, acute to obtuse or rounded and ± apiculate, entire, strongly bordered by linear cells; costa percurrent or nearly so or sometimes ending in the apiculus; upper cells rounded-hexagonal or somewhat elongate in a transverse or oblique direction, smooth, firm- or rather thick-walled, often pitted; lower cells rectangular. Setae single, elongate, erect; capsules pendent, oblong-cylindric or broadly pyriform, with a short neck; annulus deciduous in fragments; operculum hemispheric, sometimes mammillate; stomata immersed, restricted to the neck; peristome deeply inserted, the teeth short and blunt or emarginate, often irregular at the margins, pale- or greenish-yellow, finely papillose; endostome much longer, dark- or yellow-brown, finely papillose, originally a continuous, covered cylinder but becoming ruptured at maturity because of adherence to the teeth, resulting in a pleated dome supported by irregular, keeled columns alternating with the teeth. Spores spherical. Calyptra cucullate, smooth, naked.—The name refers to spaces of a lattice, in this case to spaces of the endostome which is like a cupola supported by pillars alternating with the teeth of the exostome.

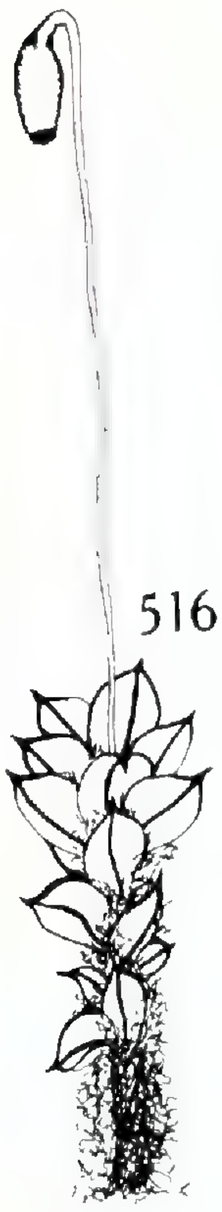
**Cinclidium stygium** Sw.—Plants in loose tufts 3-8, rarely 13 cm. high, red-brown or green with red tinges above, dark-red or blackish below (light-green and dewey-wet in appearance when growing). Stems reddish, becoming blackish with age. Leaves erect-spreading, contorted when dry, 4-6 mm. long, broadly obovate, rounded-obtuse and abruptly narrowed to a long, red apiculus; margins often ± revolute below; costa reddish, shortly excurrent; cells obliquely or transversely elongate-hexagonal, with rather thick, pitted walls, not thickened at the corners, 3-4 marginal rows narrow and thick-walled forming a strong, red or red-brown border. Synoicous. Setae 40-65 mm. long, slender, flexuose, rarely in pairs; capsules 2-3 mm. long, shortly pyriform; annulus of 1 row of cells; operculum sometimes mammillate; peristome teeth pale-yellowish; endostome dark-brown. Spores extremely variable even in the same capsules, 31-68 $\mu$, very finely roughened.—n = 14.

Darlington, Mosses of Michigan, fig. 78. Grout, Mosses with Hand-lens and Microscope, Pl. 5 (fig. 14), Moss Flora of North America 2: Pl. 106.—**Fig. 516-519.**

In open, calcareous fens, near trickling springs or among sedges near pools. Circumpolar; Greenland to Alaska and south to Quebec, New York, and Michigan.

CHEBOYGAN CO.—Grass Bay. EMMET CO.—Cecil Bay. MACKINAC CO.—Bois Blanc Island, Mud Lake. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Clinton Lake.

Rare in our area. Similar to *Mnium punctatum* in many ways. The younger leaves have a lovely dewey-green freshness that is lost on drying. The older parts are red or purplish-black (a gloomy, stygian color). The strong, red border and the strong apiculus, red even in young leaves, are good characters for recognition.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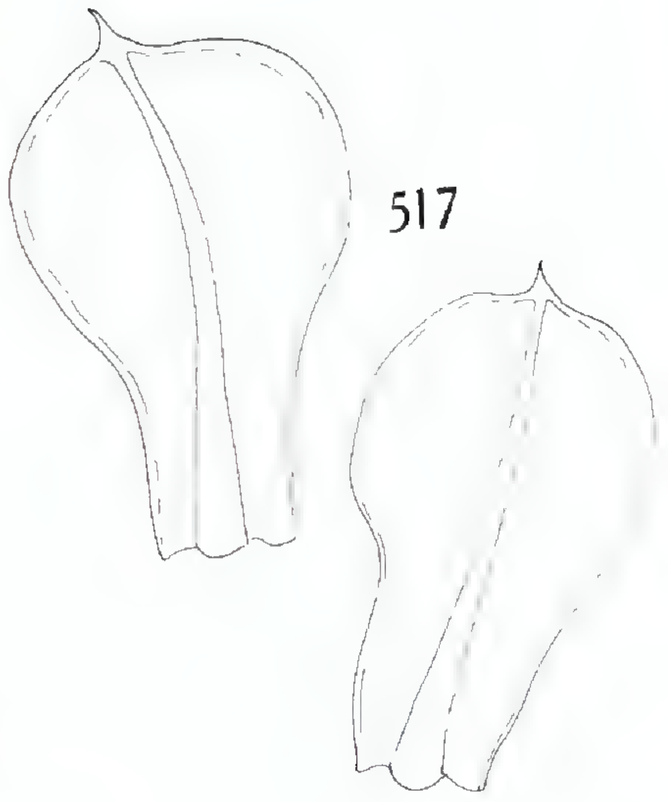
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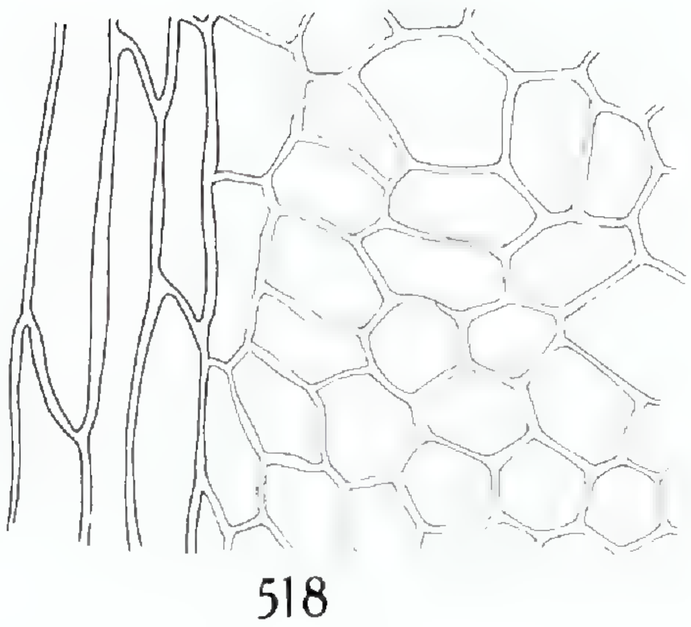
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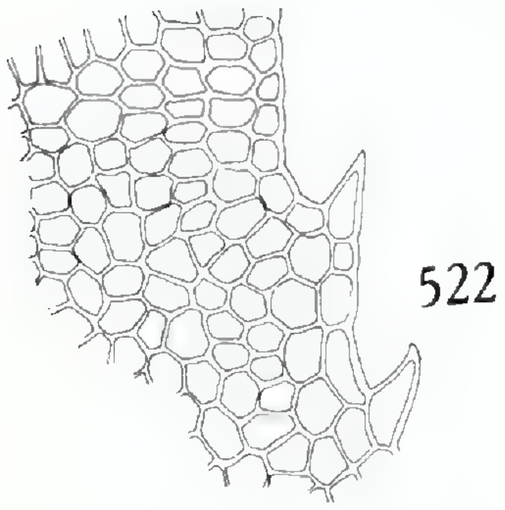
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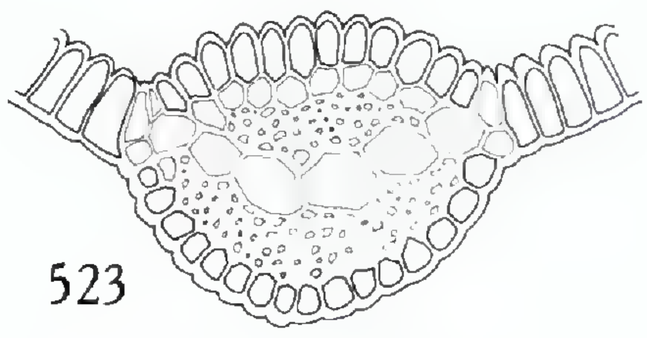
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*Cinclidium stygium.* 516. Habit. 517. Leaves. 518. Upper cells at margin of leaf. 519. Portion of peristome.

*Timmia megapolitana.* 520. Habit. 521. Leaves. 522. Upper cells at leaf margin. 523. Cross-section of costa.

## TIMMIACEAE

Rather coarse plants in dull, dark-green or yellowish tufts, brown below, rigid when dry. Stems erect, simple or forked. Leaves in many rows, sometimes somewhat larger and ± tufted at the stem tips, spreading to wide-spreading from an erect, half-sheathing base, incurved-contorted when dry, keeled or subtubulose, unbordered, ± serrate; costa single, ending at or near the apex, sometimes toothed at back above; cells of the limb small and green, rounded-quadrate or rounded-hexagonal, mammillose on the upper surface, those of the sheathing base long-rectangular to linear, narrower toward the margins, pale and hyaline, orange, or red, sometimes papillose at back. Perichaetial leaves not much differentiated; paraphyses of perigonia filiform. Setae terminal, elongate, erect; capsules inclined to pendulous, oblong-ovoid or oblong-cylindric from a short neck, brown, firm, often furrowed when dry and empty; annulus broad, sometimes revoluble; operculum hemispheric, usually ± apiculate;

stomata in the neck or sometimes also in the lower half of the urn; peristome double, inserted well in from the mouth and attached to it by a membrane, the 16 teeth abruptly incurved when dry, lanceolate, rarely perforate along the middle or split at the apex, yellowish and papillose or transversely punctate-striate below, whitish, papillose, and vertically barred above; endostome as long as the teeth, consisting of a high, keeled, cross-striolate basal membrane and 64 papillose cilia mostly ± grouped or attached in 2's or 4's (especially at the tips), sometimes appendiculate on the inner side. Spores spherical. Calyptrae long and narrow, cucullate, smooth and naked, often adhering to the tip of the seta at maturity.—Consisting of a single genus, **Timmia** Hedw., named for Joachim Christian Timm of Malchin in the former German state of Mecklenburg, author of the *Florae Megapolitanae Prodromus.* The endostome consisting of 64 cilia is an unusual and attractive feature of the genus. Mount Timmia on Ellesmere Island was recently named for this genus, at the suggestion of a Canadian bryologist, Guy Brassard.

**Timmia megapolitana** Hedw.—Plants in loose, dirty-green tufts 1.5-6, rarely 8 cm. high, ± radiculose below. Leaves 5-8, rarely 10 mm. long, subtubulose and curled when dry, wide-spreading from an erect base and concave when moist, gradually oblong-lanceolate from an oblong, sheathing base, broadly and bluntly acute; margins coarsely serrate above, serrulate to the shoulders or somewhat below, incurved when dry, plane or erect when moist; costa subpercurrent, mammillose on the upper surface (and sometimes somewhat mammillose-roughened near the apex at back); upper cells 8-13(16) $\mu$ wide, rounded-hexagonal; basal cells oblong-linear, yellow-brown or brown, those of the upper median region of the sheath often bearing several papillae in a row over the lumina at back. Autoicous (with 1-several perigonial buds at the base of the perichaetium). Setae single or occasionally paired, 10-30 mm. long, becoming red; capsules 2.5-3 mm. long, broadly oblong-cylindric, curved and asymmetric, not or only slightly furrowed when dry; annulus persistent; operculum hemispheric, not apiculate; stomata in the lower half of the urn or nearly throughout; peristome teeth yellow-brown and finely papillose below, pale-yellow or whitish and coarsely papillose and vertically barred above; endostome with 64 evenly spaced, yellowish or whitish, papillose filaments bearing fine, inwardly directed appendages at the nodes. Spores 11-16 $\mu$, very finely papillose. Calyptra clasping the tip of the seta after falling from the urn.—n = 12, 16.

Conard, How to Know the Mosses, (ed. 2) fig. 55. Grout, Mosses with Hand-lens and Microscope, Pl. 43. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 25 & (ed. 2) Pl. 29 (as *T. cucullata*). Welch, Mosses of Indiana, fig. 108.—**Fig. 520-523.**

On moist or wet, shaded soil or humus, sometimes on rotten logs, typically along streams, sometimes on banks of ravines. Circumpolar; Alaska to Quebec, south to Nebraska, Arkansas, and Virginia (more common in the East.)

CHEBOYGAN CO.—Reeses Bog, Douglas Lake, Mill Creek, Black Lake. EMMET CO.—Maple River, Wycamp Lake, Cross Village. MACKINAC CO.—Mackinac Island. PRESQUE ISLE CO.—Ocqueoc River.

Resembling an *Atrichum* or a *Polytrichum* in aspect. The leaves rolled and incurved when dry, with ventrally bulging cells, and the details of the peristome are highly distinctive. The way in which the calyptra remains attached to the tip of the seta after slipping off the mature capsule aids in recognition. The var. **bavarica** (Hessl.) Brid., a western expression which has been found in the Thunder Bay District of Ontario, has smaller, more angular cells often somewhat longer than wide (6-7 $\mu$ wide and isodiametric or sometimes about 11 $\mu$ long). In montane habitats of the Upper Peninsula, we have **Timmia austriaca** Hedw. It has cells of the leaf base orange and

smooth, filaments of the endostome somewhat nodose and in groups of four, and dioicous inflorescences.

Lazarenko (Bryol. 60: 14-17. 1957) noted a curious behavior in the double peristome of *Timmia megapolitana* var. *bavarica*: The teeth are joined at their tips in pairs thus forming eight triangles, the broad apices of which cannot penetrate between the cilia of the endostome, as in double bryoid or hypnoid peristomes. Because of the joined tips, the teeth spread outward in their lower parts and inward at the tips. When hygroscopic movements begin, the teeth squat down and bulge outward at the middle, while the incurved tips skim up and down ploughing the spores and jumping over nodes of the cilia. Because of such disturbance the cilia throw out spores rather than merely allow their dispersal in a salt-shaker fashion.

## AULACOMNIACEAE

Plants small to rather robust, in dull, green, yellow-green, or yellow-brown, usually tomentose tufts. Stems erect, simple or forked. Leaves in many rows, not or rarely somewhat complanate, erect to erect-spreading, scarcely altered to contorted when dry, sometimes ± larger at the stem tips, lanceolate to oblong-ovate or elliptic, acute to rounded at the apex, sometimes apiculate, concave or keeled, unbordered, generally toothed above; costa single, strong, ending somewhat below the apex (or sometimes considerably below it), with 2 stereid bands; upper cells small, rounded, rounded-hexagonal, or elliptic, thick-walled, smooth or unipapillose on both surfaces; lower cells mostly somewhat longer or rectangular, sometimes swollen at the insertion. Setae terminal, ± elongate, erect; capsules usually inclined to horizontal, symmetric or ± curved and asymmetric, oblong-ovoid to cylindric from a short neck, plicate when dry; annulus broad; operculum conic to rostrate, sometimes obliquely so; stomata restricted to the neck; peristome double, the 16 teeth lanceolate, papillose; endostome hyaline, with a low or high basal membrane, narrow segments sometimes slit or gaping along the median line, and delicate to stout cilia. Calyptrae cucullate.

### **Aulacomnium** Schwaegr.

Plants small to robust, in dull, yellow-green, yellow-brown, or green, radiculose tufts. Stems erect, simple, or forked. Leaves crowded, erect or erect-spreading, scarcely altered on drying to strongly contorted, oblong-lanceolate to ovate or elliptic, acute to obtuse or rounded, sometimes apiculate, not or somewhat decurrent, concave or keeled; margins entire or toothed above, usually ± revolute; costa tapered, usually flexuose above, typically ending somewhat below the apex; cells rounded or shortly oblong to elliptic, ± incrassate and sometimes collenchymatous or stellate, smooth or unipapillose on both surfaces, short and scarcely differentiated to somewhat elongate below, sometimes colored and somewhat swollen at the insertion. Setae elongate, smooth; capsules suberect to horizontal, subcylindric, asymmetric and usually somewhat curved, contracted below the mouth when dry; annulus revoluble; operculum bluntly conic to stoutly and obliquely short-rostrate; peristome teeth pale, yellow-brown; endostome hyaline, with a high basal membrane, keeled and usually gaping segments, and long, slender, nodulose cilia in groups of 2-4 (or rarely 5). Spores spherical. Calyptrae smooth, naked.—The name means furrowed *Mnium,* referring to a moss with ribbed capsules.

1. Plants autoicous; leaves concave, broadly oblong or oblong-ovate, coarsely serrate in the upper half, erect and ± homomallous, scarcely contorted when dry; cells smooth
1. *A. heterostichum*
1. Plants dioicous; leaves ± keeled, narrower, oblong-lanceolate, serrulate near the apex, loosely erect and curved or contorted when dry, not homomallous; cells unipapillose on both surfaces
2. Fairly robust plants; leaves contorted when dry; upper cells collenchymatous and ± stellate; cells at leaf insertion ± swollen and usually brownish in several rows; sterile stems usually bearing triangular brood bodies in clusters at the tip of a seta-like extension of the stem and also, sparsely, along the extension 3. *A. palustre*
2. Rather small plants; leaves ± curved but usually not particularly contorted when dry; upper cells irregularly rounded or rounded-hexagonal; cells at insertion not or only slightly differentiated; sterile stems usually bearing a dense cluster of very small, fusiform brood bodies at the end of a seta-like extension of the stem (and not along its length)
2. *A. androgynum*

1. **Aulacomnium heterostichum** (Hedw.) BSG—Plants in rather loose, green or sometimes yellow-brown tufts 1.5-4 cm. high. Leaves rather soft, concave and slightly undulate, erect and somewhat homomallous, not altered on drying, 2-3.5 mm. long, oblong or oblong-ovate, not decurrent, subacute or obtuse and apiculate; margins plane or narrowly recurved below the middle, coarsely serrate in the upper ½ or more; costa not flexuose, ending somewhat below the apex; upper cells small, green, smooth, thick-walled, irregularly rounded-quadrate, rounded-hexagonal, and transversely short-oblong, 9-11, often 15 $\mu$ wide; basal cells similar, those at the insertion somewhat longer, not colored or swollen. Autoicous; perigonia small, axillary. Setae 8-17 mm. long; capsules 2.5-3.5 mm. long, suberect or inclined, somewhat curved; operculum obliquely rostrate; endostome segments not perforate. Spores 9-15 $\mu$, very finely papillose.—n = 12.

Breen, Mosses of Florida, Pl. 57 (fig. 5-7). Conard, How to Know the Mosses, (ed. 2) fig. 143. Grout, Mosses with Hand-lens and Microscope, fig. 100. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 24 & (ed. 2) Pl. 28. Welch, Mosses of Indiana, fig. 109.—**Fig. 524-526.**

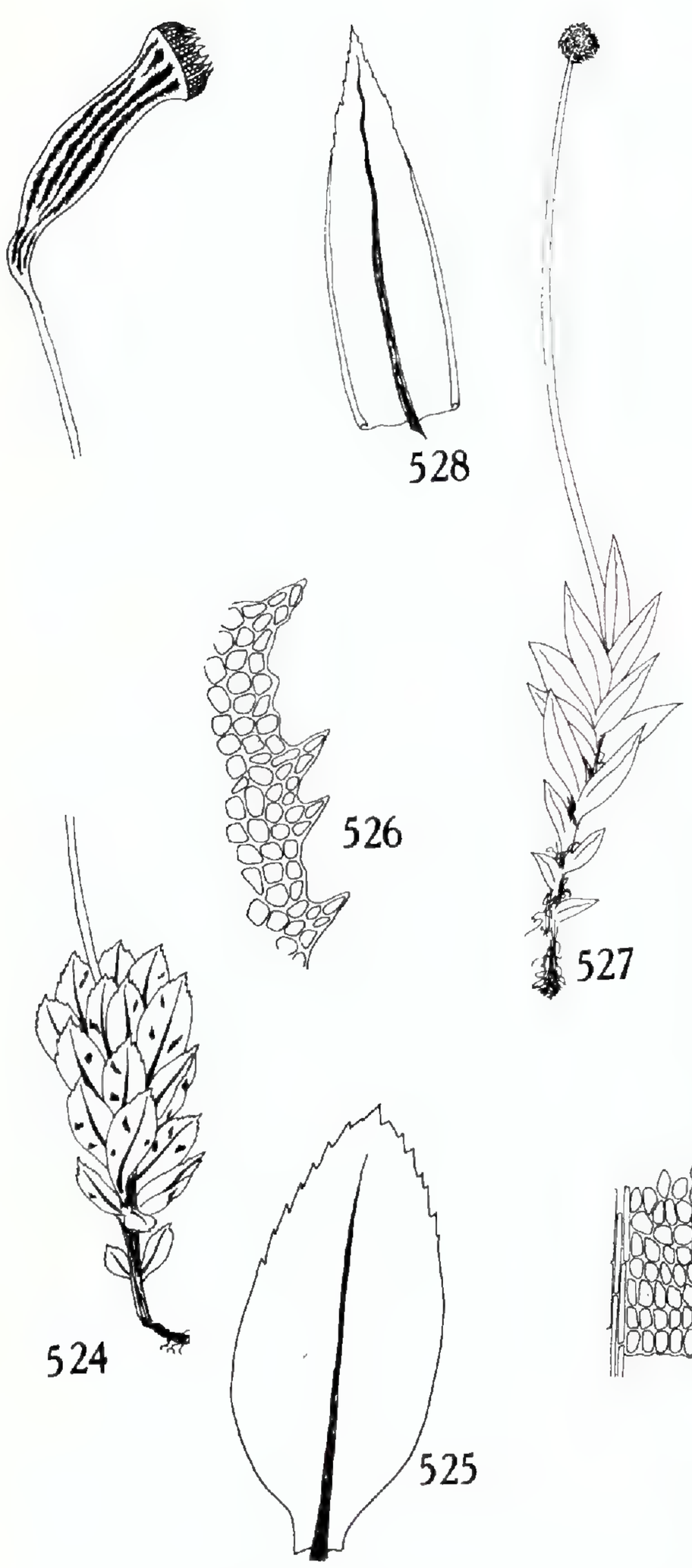
On soil or the bases of trees and stumps in rather dry to moist woods. Widespread in eastern North America.

CHEBOYGAN CO.—Douglas Lake.

An attractive moss common farther south, in oak-hickory woods, where it is often associated with *Bartramia pomiformis* on shaded ravine banks. The broad, coarsely toothed leaves and smooth cells are diagnostic.

The development of the peristome is described by Blomquist and Robertson (Bull. Torrey Bot. Club 68: 569-584. 1941). Other references concerning peristome development include Cavers (New Phytol. Reprint 4, pp. 177-189. 1910-11), Evans & Hooker (Bull. Torrey Bot. Club 40: 97-109. 1913, on *Ceratodon purpureus*), Kreulen (Lindbergia 1: 153-160. 1973), Proskauer (Amer. Jour. Bot. 45: 560-563. 1958, on *Funaria hygrometrica*), Saito (Bot. Mag. Tokyo 69: 53-58. 1956, on *Dicranum japonicum*), Saito & Shimozu (Bot. Mag. Tokyo 68: 55-60. 1955, on *Bartramia crispata*), Stone (Austral. Jour. Bot. 9: 124-151. 1961, on *Mittenia plumula*), van der Wijk (Rec. Trav. Bot. Neerl. 26: 289-395. 1929; pp. 1-40 *in* Verdoorn's *Manual of Bryology*. 1932).

For detailed structure and evolutionary significance of peristomes: Philibert (Rev. Bryol. 11: 49-52, 65-72, 81-87. 1884; 12: 67-77, 81-85. 1885; 13: 17-27, 81-86. 1886; 14: 9-11, 81-90. 1887; 15: 6-12, 24-28, 37-44, 50-60, 65-69, 90-93. 1888; 16: 1-9, 38-44, 67-77. 1889; 17: 8-12, 25-29, 38-42. 1890; 23: 36-38, 41-56. 1896; 28: 56-59, 127-130. 1901; 29: 10-13. 1902) or, for an abridged translation, Taylor [Bryol. 65(3): 175-212. (1962)1963]; van der Wijk (Buxbaumia 5: 10-17. 1951). Grout's notes on




*Aulacomnium heterostichum.* 524. Habit. 525. Leaf. 526. Upper cells of leaf.
*Aulacomnium androgynum.* 527. Habit of sterile plant. 528. Leaf. 529. Cells at insertion of leaf.
*Aulacomnium palustre.* 530. Habit. 531. Leaf. 532. Upper cells of leaf. 533. Basal cells of leaf.

peristome structures (Bryol. 4: 31-32. 1901; 5: 53-56, 73-74, 94-95. 1902; 6: 63-65. 1903; 7: 37-39. 1904) are commendable because of illustrations. Details of peristome structures as revealed by the scanning electron microscope are beautifully portrayed by Robinson (Bryol. 74: 473-473. 1972).

*Aulacomnium heterostichum* is quite unlike other members of the genus in aspect, and efforts have been made to set it apart as the genus *Arrhenopterum,* on the basis of broad, toothed, secund leaves and an apparent lack of "pseudopodia" and propagula. Small deciduous leaves were found, however, in a colony of plants in southern Michigan by Lowry and Steere (Bryol. 49: 30-32. Fig. 1-6. 1946). Though probably induced by some unusual feature of the environment, such brood leaves provide some evidence of relationship to *A. palustre* and *A. androgynum.*

2. **Aulacomnium androgynum** (Hedw.) Schwaegr.–Small plants in rather dense, dark-green or sometimes yellow-brown tufts 1-2.5 (rarely 4.5) cm. high; sterile plants commonly bearing very small, ± spindle-shaped propagula in dense, globose clusters of the end of a smooth, seta-like extension of the stem. Lower leaves small and distant, upper larger and ± crowded, loosely erect and somewhat curved but not much contorted when dry, 1-3.5 mm. long, narrowly to broadly oblong-lanceolate, acute, decurrent, somewhat keeled; margins narrowly revolute below and often nearly to the apex (or in leaves of innovations sometimes plane), distinctly serrulate near the apex or in the upper ½ and often crenate-serrulate nearly to the base; costa flexuose above, ending somewhat below the apex; cells irregularly rounded or rounded-hexagonal, moderately thick-walled, 5-11 $\mu$ wide (mostly 7-9 $\mu$), bluntly unipapillose on both surfaces; basal cells similar, those at the insertion sometimes ± elongate, not brownish or swollen. Dioicous; male plants repeatedly forked by innovations, the perigonia large, terminal. Setae 11-25 mm. long; capsules 2-2.3 mm. long, suberect to strongly inclined, not curved; operculum bluntly conic; segments of endostome gaping. Spores 9-11 $\mu$, smooth.–n = 10, 11-12, 12.

Conard, How to Know the Mosses, (ed. 2) fig. 85e-g. Grout, Moss Flora of North America 2: Pl. 66C.–**Fig. 527-529.**

A woodland species, on soil or humus of banks, sometimes on rotten wood. Europe, Canary Islands, Japan; Alaska to Newfoundland, south to California, Wyoming, the Great Lakes, and West Virginia.

CHEBOYGAN CO.–Gorge of Carp Creek, Iron Bridge, Burt Lake. EMMET CO.–Stutsmanville, Cross Village. MACKINAC CO.–McNamara Pond.

The specific epithet, indicating a hermaphroditic or monoicous sexual situation, was inappropriately applied by Linnaeus. The species is much less common than *A. palustre,* with which it is likely to be confused.

3. **Aulacomnium palustre** (Hedw.) Schwaegr.–Plants fairly robust, in loose or dense, yellow, yellow-green or yellow-brown, often conspicuously tomentose tufts 3-9 cm. high (rarely less); sterile stems often bearing clusters of ± triangular propagula at the end of a warty, seta-like extension of the stem and also, sparsely, along the extension. Leaves erect-spreading, twisted and contorted when dry, 2-4 mm. long, keeled, oblong-lanceolate, acute or acuminate, somewhat decurrent; margins serrulate or serrulate-papillose toward the apex, revolute in the lower ¾; costa flexuose above, ending somewhat below the apex; upper cells 9-13 $\mu$ wide, isodiametric, thick-walled, collenchymatous and ± stellate, unipapillose on both surfaces; basal cells similar except for several rows of pale to brownish, somewhat swollen cells with moderately thickened, straight walls at the insertion. Dioicous; perigonia large, terminal. Setae 25-45 mm. long; capsules 2.5-4 mm. long, strongly inclined to horizontal, curved; operculum bluntly conic to stoutly and obliquely short-rostrate; segments of endostome gaping. Spores 11-13 $\mu$, smooth.–n = 9, 10, 11, 12.

Breen, Mosses of Florida, Pl. 57 (figs. 1-4). Conard, How to Know the Mosses, (ed. 2) fig. 85a-d. Darlington, Mosses of Michigan, fig. 79. Grout, Mosses with Hand-lens and Microscope, fig. 101, 102, Moss Flora of North America 2: Pl. 66A. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 24, (ed. 2) Pl. 28. Welch, Mosses of Indiana, fig. 110.–**Fig. 530-533.**

Very common on various substrata, particularly soil or humus, in swamps, fens, and burned-over bogs. Nearly cosmopolitan; Greenland to Alaska, south to the Gulf of Mexico, New Mexico, Arizona, and California.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Douglas Lake, Gleasons Bog, Wolffs Bog, Maloneys Bog, Livingston Bog, Bryants Bog, Gates Bog, Vincent Lake, Smiths Bog, Mud Lake, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.–Pellston, Levering, Galloway Bog, Maple River, Pleasantview Swamp, Stutsmanville, Conway Bog, Wycamp Lake, Wilderness State Park, Cecil Bay. MACKINAC CO.–Bois Blanc Island, Rexton, St. Martins Bay, Nunns Creek, St. Martins Point, McKays Creek, Hog Island Point, Epoufette, Ozark, Peggley Lake, Hendricks. PRESQUE ISLE CO.–Evergreen Beach, Hammond Bay, Mast Point, Clinton Lake.

This exceedingly common moss is larger than *A. androgynum* and has brownish, swollen cells near the leaf insertion. The gemmae are triangular (and thus more or less leaf-like) and borne along a seta-like extension of the stem, in a leaf-like arrangement, and also crowded in an apical cluster. *A. androgynum* has tiny, spindle-shaped gemmae borne only at the apex of a similar extension of the stem (sometimes called a pseudopodium).

*Aulacomnium palustre* may be green or brown, but it always has a sickly yellow cast as well.

**Aulacomnium acuminatum** (Lindb. & H. Arn.) Par., a rare arctic and boreal species not included in Grout's *Moss Flora,* has been found in the Thunder Bay District of Ontario. Compared with *A. palustre,* the plants are quite robust, lack brood bodies, and have leaves which are erect or imbricate and not at all contorted when dry; the margins are entire and strongly revolute nearly the length of the leaf.

Common northward is **A. turgidum** (Wahl.) Schwaegr., distinguished from *A. palustre* especially by rounded-obtuse leaves with smooth cells. The leaves are imbricate and scarcely altered on drying. When well developed, the stout, julaceous, essentially simple stems look like large yellowish caterpillars.

## MEESIACEAE

Plants slender to rather robust, gregarious to tufted, dull, dirty-green or yellowish to light-green and rather shiny, radiculose or tomentose below. Stems erect, forked. Leaves in 3-8 rows, erect or erect-spreading to squarrose-recurved from an erect base, lance-ligulate to ovate-lanceolate or obovate, acute to rounded-obtuse, unbordered, sometimes toothed above, rarely to the base; costa single, strong, mostly ending below the apex; cells rounded- or oblong-hexagonal or rectangular, mostly with firm- or thick-walls, smooth (or rarely mammillose); lower cells rectangular, often delicate and hyaline. Paraphyses of perigonia clavate, those of the perichaetia (if present) filiform. Setae terminal, elongate, erect-flexuose; capsules suberect or inclined, strongly curved and asymmetric, oblong-pyriform from a rather short or fairly long neck, small- and oblique-mouthed, smooth; annulus narrow, deciduous in fragments; operculum small, convex or bluntly short-conic; stomata numerous, in the neck; peristome double, in *Paludella* consisting of 16 well-developed teeth and segments of a length equal to them, rising from a rather low basal membrane, otherwise the 16 teeth much shorter than the endostome, fused at base or nearly throughout, blunt or truncate at the apex, the endostome consisting of a very low basal membrane adhering to the teeth, long, linear, keeled segments slit along the middle and mostly irregular at the margins, and cilia rudimentary or lacking (the inner peristomial layer sometimes incompletely resorbed, leaving a ± fragmentary membrane between the segments with cilia sometimes represented by irregular chains of nodose deposits on the membrane). Spores generally large. Calyptrae cucullate, smooth.

1. Leaves strongly squarrose-recurved from an erect base, in 5 distinct rows; cells mammillose on both surfaces; segments about as long as the teeth 3. *Paludella*
1. Leaves erect, spreading, or squarrose but not recurved, not in distinct rows, or if so, 3-ranked; cells smooth; segments twice as long as the teeth or longer
 2. Soft, delicate plants with leaves oblong-lanceolate, rather abruptly narrowed to a short, sharp point, shrunken when dry; leaf cells lax and thin-walled; perichaetial leaves not differentiated 1. *Amblyodon*
 2. Coarser, firmer plants; leaves not shrunken when dry, oblong-lanceolate to lance-ligulate, rounded-obtuse or gradually acute; cells firm; perichaetial leaves elongate 2. *Meesia*

## 1. **Amblyodon** BSG, *nom. cons.*

A monotypic genus, so named because of blunt peristome teeth.

**Amblyodon dealbatus** (Hedw.) BSG—Plants small, gregarious or tufted, pale- or bright-green with red tinges, shiny, soft, somewhat radiculose at base, up to 1 (or rarely 3) cm. high, considerably forked by short branches. Leaves crowded, erect and not or slightly contorted when dry, loosely erect or erect-spreading when moist, 2-4 mm. long, keeled (especially when dry), oblong-lanceolate, gradually or abruptly acute; margins plane, ± serrulate near the apex; costa very thick and about ½ or more the width of the leaf at base, narrower above, ending somewhat below the apex, becoming reddish to blackish; cells smooth, pale, lax and thin-walled, oblong-hexagonal and shortly oblong-rhomboidal, narrower in a single marginal row but not forming a noticeable border, not much different at base. Polygamous (perichaetia and perigonia on the same plants but archegonia occasionally found in the perigonia). Seta 12-40 mm. long, orange-brown, smooth; capsules 2-3 mm. long, elongate-pyriform, strongly curved and asymmetric from an erect, well-marked neck, yellow-brown; operculum bluntly conic; peristome teeth inserted near the mouth, short, lanceolate, blunt or truncate, finely papillose, yellow- to dark-brown, trabeculate at back; endostome up to twice as long as the teeth, distinctly papillose to nearly smooth, hyaline or yellowish, consisting of a low basal membrane, narrow, keeled, and perforate segments, and cilia lacking or reduced to single, short, stout stubs. Spores 29-40 $\mu$, spherical, brown or orange-brown, finely to rather coarsely papillose.—n = 14, 18, 20.

Darlington, Mosses of Michigan, fig. 81. Grout, Moss Flora of North America 2: Pl. 63A.—**Fig. 534-535.**

On peaty soil or sometimes on logs in wet or seepy places such as bogs and river banks. Europe, Caucasus, Persia, and Central Asia; Yukon to British Columbia and Colorado, also Manitoba to Nova Scotia and south to the Great Lakes region.

MACKINAC CO.—Mackinac Island. PRESQUE ISLE CO.—Hammond Bay.

Thy lax, thin-walled leaf cells suggest the Funariaceae, but the capsule gives indisputable evidence of a relationship to *Meesia* and *Paludella*.

## 2. **Meesia** Hedw., *nom. cons.*

Plants medium-sized to fairly robust, in dense, sordid-green or yellowish tufts, brown or blackish and densely radiculose below. Stems bearing small club-hairs with red bases in axils of uppermost leaves and perichaetial and perigonial bracts. Leaves erect to wide-spreading or squarrose, sometimes clearly 3-ranked, not or distinctly decurrent, oblong-lanceolate or oblong-ovate to lance-ligulate, acute to rounded-obtuse; margins entire or serrulate, plane or revolute; costa strong, broader at the base

(sometimes as much as ½ or more the width of the leaf base), ending near the apex; upper cells short-rectangular, smooth, with thin to firm walls; lower cells longer, rectangular, pale. Perichaetial leaves similar, not or somewhat elongate. Setae usually very long, yellow-brown; capsules elongate-pyriform, curved and asymmetric from an erect, elongate, well-defined neck, inclined to horizontal, brown, shiny; annulus rather poorly differentiated; operculum hemispheric to bluntly conic; peristome inserted below the mouth, the teeth short, blunt or truncate, brown or yellow-brown, minutely papillose and indistinctly cross-striolate but usually appearing nearly smooth; endostome 2-4 times as long as the teeth, yellowish-brown, smooth, consisting of a low basal membrane, narrow, keeled, and slightly perforate segments with irregular, crenate-bulging margins, and 2-4 rudimentary or irregularly developed cilia, sometimes ± continuous and about as long as the segments but more often represented by a chain of fragments adhering to a delicate, incomplete, hyaline membrane resulting from incomplete resorption of the inner peristomial layer. Spores large, irregularly spherical. —The genus was named for David Meese, a Dutch gardener. The pear-shaped capsule curved above a long, erect neck gives a distinctive look to the genus and the family.

Plants 1-2.5 cm. high; leaves erect, not 3-ranked, keeled, or decurrent, narrowly lance- or linear-ligulate; margins strongly recurved, entire ..... 1. *M. uliginosa*
Plants 3-12 cm. high; leaves spreading to squarrose from an erect base, ovate-lanceolate, 3-ranked, keeled and decurrent; margins not or sometimes indistinctly revolute, serrulate above the shoulders ..... 2. *M. triquetra*

1. **Meesia uliginosa** Hedw.—Plants 10-25 mm. high. Leaves not 3-ranked, erect and often ± contorted when dry, erect when moist, 2-4 mm. long, narrowly lance-ligulate to linear-ligulate, obtuse or rounded-obtuse, not keeled or decurrent; margins entire, revolute in the lower 1/2 or nearly to the apex; costa about 1/2-2/3 the width of the leaf base. Polygamous (usually dioicous, but sometimes autoicous or with both synoicous and antheridial inflorescences on the same plants). Setae (10)20-70 mm. long; capsules 1.5-4 mm. long; operculum hemispheric and flat-topped. Spores 40-51 $\mu$, brown, densely and finely papillose.—n = 13, 13+1, 14, 14+1.

Conard, How to Know the Mosses, (ed. 2) fig. 159a,e-f. Grout, Moss Flora of North America, 2: Pl. 64A.—**Fig. 536-538.**

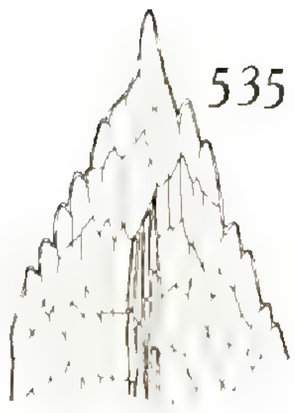
On wet soil or peaty humus, rarely on logs, especially in marly fens or swamp forests, sometimes in crevices of cliffs; a calciphile. Circumpolar; Greenland to Alaska and south to New York, Michigan, Colorado, and California.

CHEBOYGAN CO.—Reeses Bog, Iron Bridge, Nichols Bog, Duncan Bay, Grass Bay. EMMET CO.—Cecil Bay. MACKINAC CO.—Cedarville. PRESQUE ISLE CO.—Evergreen Beach, Hammond Bay, Mast Point.

The erect, ligulate, blunt leaves with the costa very broad, especially at the base, are unmistakable.

2. **Meesia triquetra** (L. *ex* Richt.) Ångstr.—Plants 3-12 cm. high. Leaves 3-ranked, somewhat to strongly contorted when dry, spreading to squarrose-spreading from an erect base, (1.5)2.5-4 mm. long, ovate-lanceolate, keeled above the shoulders, gradually narrowed to a slenderly acute apex, distinctly decurrent; margins plane or sometimes ± reflexed or revolute near the shoulders, distinctly serrulate from the shoulders to the apex; costa somewhat broader at base but considerably less than 1/3 the width of the leaf base. Dioicous; perichaetial leaves not very elongate, about 4-4.5 mm. long. Setae 30-100 mm. long; capsules 3-4.5 mm. long; operculum bluntly conic. Spores 33-38 $\mu$, yellow-brown, very minutely roughened or nearly smooth.—n = 10.

534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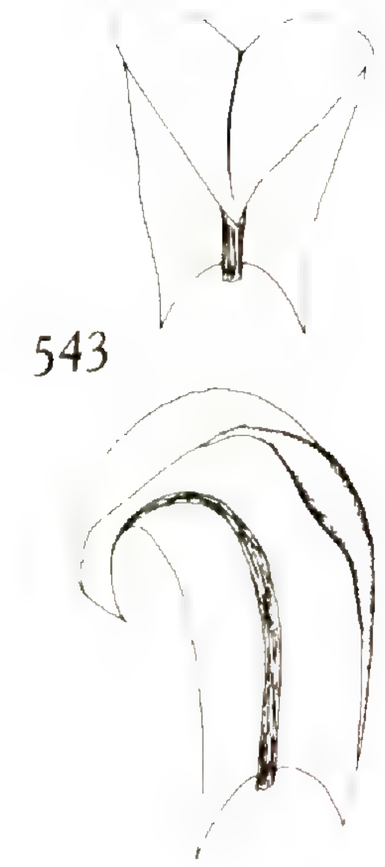
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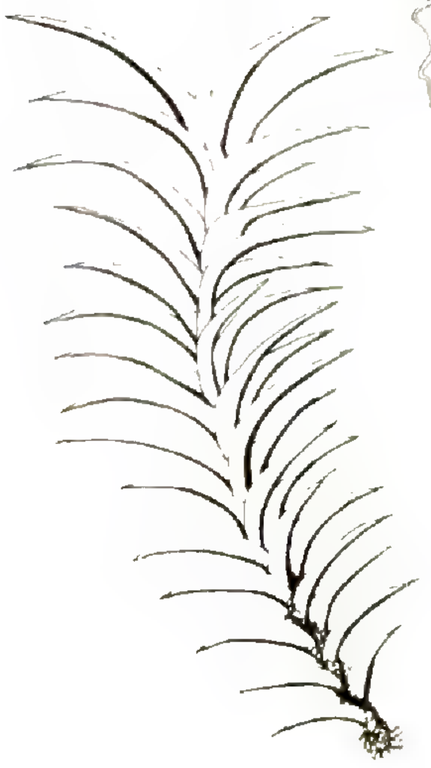

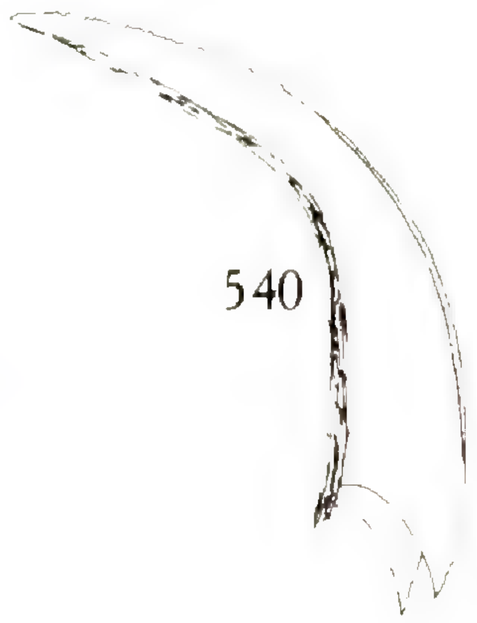
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*Amblyodon dealbatus.* 534. Leaf. 535. Cells at apex of leaf.
*Meesia uliginosa.* 536. Habit. 537. Leaf. 538. Upper cells of leaf.
*Meesia triquetra.* 539. Habit. 540. Leaf. 541. Upper cells of leaf.
*Paludella squarrosa.* 542. Portion of plant. 543. Leaves. 544. Capsule.

Conard, How to Know the Mosses, (ed. 2) fig. 159b-d. Darlington, Mosses of Michigan, fig. 82 (as *M. tristicha*). Grout, Mosses with Hand-lens and Microscope, Pl. 42.–**Fig. 539-541.**

A calciphile, on wet soil or humus in marly bogs or swamp forests. Circumpolar; Alaska to Greenland, south to California, Ohio, and Pennsylvania.

CHEBOYGAN CO.–Mud Lake, Little Lake 16. EMMET CO.–Conway Bog.

Extremely rare locally but easily recognized by the spreading leaves in three obvious ranks. A similar species, **M. longiseta** Hedw., has been found in a few localities in other glaciated portions of the eastern United States and adjacent Canada. It has entire leaves (or rarely somewhat serrulate), elongate perichaetial leaves, synoicous inflorescences, and brown spores about 36-44 $\mu$ in diameter.

### 3. **Paludella** Brid.

Rather robust plants in dense tufts, dull, pale-green to yellowish- or brownish-green above, brown or rarely blackish and tomentose below; small, purplish, clavate hairs ("club-hairs") in leaf axils. Leaves in 5 distinct rows, strongly squarrose-recurved from an erect base, scarcely altered on drying, obovate, broadly acuminate and acute, narrowly long-decurrent, strongly keeled; margins narrowly recurved below and broadly reflexed at the middle, serrulate above; costa slender, serrulate at back above, vanishing below the apex; upper cells rounded-hexagonal, rather thick-walled, mammillose on both surfaces; basal cells smooth, rectangular. Dioicous; perigonia rosulate; perichaetial leaves elongate, lance-acuminate. Setae long, brown or reddish; capsules suberect or inclined, subcylindric, tapered from a short neck, asymmetric, ± curved, brown; operculum convex or bluntly low-conic; peristome teeth lanceolate, pale-yellow, densely and finely papillose; segments of endostome about as long as the teeth, narrowly perforate along the keel, lightly papillose to nearly smooth, rising from a rather low basal membrane, the cilia lacking or reduced to mere stubs. Spores spherical, relatively small, finely papillose.—The name is a diminutive referring to a swampy habitat.

**Paludella squarrosa** (Hedw.) Brid.—Tufts 4-7, rarely 15 cm. high. Leaves 1.5-2 mm. long; upper cells 10-13 $\mu$ wide. Setae 2.5-4.5 cm. long; capsules 2-3 mm. long. Spores 15-21 $\mu$, brownish.

Darlington, Mosses of Michigan, fig. 80. Grout, Moss Flora of North America 2: Pl. 63B.—**Fig. 542-544.**

A species of calcareous fens not yet found in the Straits counties, although known from a few localities in both Upper and Lower Peninsulas of Michigan (Alger, Keweenaw and Montcalm Counties). It should be sought especially at the sedgey margins of beach pools fringing the Great Lakes. Circumpolar; Alaska to Greenland, south to New York, Michigan, Wyoming, and Montana.

Certainly one of our most attractive and curious mosses, unlike anything else in its tomentose stems and extremely squarrose-recurved leaves (and yet in structure not too unlike *Meesia triquetra*).

## CATOSCOPIACEAE

Slender plants in very dense, often deep tufts, dark-green to yellowish-brown above, dark-brown or blackish and radiculose below. Stems erect, forked. Leaves in many rows, incurved and somewhat crisped when dry, erect-spreading when moist, narrowly lance-acuminate, slenderly acute, keeled; margins entire, narrowly recurved below; costa single, narrow but well developed, disappearing in the apex; upper cells small, quadrate to short-rectangular, green, smooth, firm-walled; lower cells larger, oblong to sublinear, quadrate at the basal margins. Dioicous; perichaetial leaves larger, lance-subulate from a half-sheathing base, plane at the margins; perigonia bud-like, with filiform paraphyses. Setae terminal, erect, slender and elongate, dark-red; capsules inclined or horizontal, very small, shortly ovoid from a short neck, very asymmetric and curved, with the mouth directed downward at maturity, smooth, dark red-brown to nearly black, becoming glossy and brittle; annulus and stomata none; operculum convex, bluntly pointed; peristome teeth 16, lanceolate, short, irregular, and fragile, pale, finely papillose, incurved; endostome a very low membrane, sometimes lacking. Spores large. Calyptra cucullate, smooth, naked, sometimes adhering to the tip of the seta at maturity.—Consisting of a single monotypic genus, **Catoscopium** Brid., named in

reference to the capsule which is curved so that the mouth is directed downward (and hence "looks" down).

**Catoscopium nigritum** (Hedw.) Brid.—Plants 1.5-6 cm. high. Leaves 0.8-1.5 mm. long. Setae 8-25 mm. long; capsules 0.6-1 mm. long. Spores 33-48 $\mu$, spherical and ellipsoidal, finely papillose.—n = 13, 14.

Darlington, Mosses of Michigan, fig. 83. Grout, Moss Flora of North America 2: Pl. 67E.—**Fig. 545-547.**

A calciphile of wet habitats, typically on peaty humus at the margins of pools in fens, sometimes on limey mud or limestone cliffs, at edges of beach pools or on wet sand in depressions along the Great Lakes. Circumpolar; Alaska to Greenland, south to New Brunswick, Michigan, Iowa, and British Columbia.

CHEBOYGAN CO.—Duncan Bay. EMMET CO.—Wilderness State Park, Cecil Bay. MACKINAC CO.— Bois Blanc Island. PRESQUE ISLE CO.—Mast Point, Hammond Bay, Evergreen Beach.

The leafy plants are similar to *Ceratodon* in aspect and structure; they grow in very compact, wet, blackish tufts recognizable even in a sterile state and especially in ecological context. The sporophytes, often produced in great abundance, resemble minute golf clubs, justifying the name GOLF CLUB MOSS. The tiny capsules are a beautiful, fresh green until fully formed but later become black and shiny. They remind me of someone looking over his shoulder, calling to mind Satchel Paige's advice, in *How to Keep Young:* Don't look back. Something may be gaining on you.

## BARTRAMIACEAE

Small to robust plants in loose or dense tufts, generally tomentose below. Stems erect, with forked, fastigiate, or whorled branching. Leaves in many rows, ovate-lanceolate to linear- or lance-subulate, usually acute or acuminate, sometimes abruptly enlarged and clasping at the base, unbordered, toothed at the margins above and often at the back of the costa; costa single, ending below the apex to excurrent as a toothed point or awn; upper cells rounded-quadrate to oblong or linear, mostly firm-walled, papillose at or near 1 or both ends or sometimes centrally, rarely smooth; lower cells usually larger, lax, smooth, and hyaline, not or slightly differentiated at the basal angles. Paraphyses of perigonia filiform or clavate; perichaetial leaves usually longer but not much differentiated. Setae terminal (but often becoming lateral because of innovations), mostly ± elongate, straight or sometimes curved; capsules usually inclined or horizontal (rarely erect or pendulous), subglobose or ovoid, mostly asymmetric and oblique at the mouth, usually furrowed; annulus usually none; operculum convex or short-conic, rarely rostrate (usually flat and umbonate when dry); stomata restricted to the base of the capsule; peristome double, single, rudimentary, or lacking, inserted well inside the mouth and generally attached to it by a membrane, the 16 teeth lanceolate, yellow-brown or red-yellow, smooth or papillose, mostly unbordered, usually trabeculate and often with intermediate thickenings at back; endostome occasionally adhering to the teeth as fragments or somewhat shorter, consisting of a well-developed basal membrane, segments perforate and finally split along the keels, and cilia in groups of 1-3 (usually short, sometimes lacking). Calyptrae small, cucullate, smooth.

1. Leaf cells finely verruculose-striolate but not papillose — 1. *Plagiopus*
1. Leaf cells papillose at 1 or both ends
   2. Leaves linear-lanceolate or subulate from an erect and ± sheathing base; upper cells in 2-3 layers (at least at the margins); peristome teeth without intermediate thickenings at back — 2. *Bartramia*
   2. Leaves ovate or lanceolate, not erect or sheathing at base; upper cells unistratose; peristome teeth usually with intermediate thickenings at back — 3. *Philonotis*

## 1. **Plagiopus** Brid.

Plants in dense, radiculose, dull, olive-green or brownish tufts. Stems erect or ascending, triangular in section with a cortical layer of lax, thin-walled, hyaline cells. Leaves loosely erect or erect-spreading and somewhat curved when dry, erect-spreading when moist, narrowly lanceolate, acuminate, keeled above, not sheathing at base; margins revolute in the lower half or more, bistratose and doubly serrate toward the apex; costa percurrent or shortly excurrent, prominent at back and ± toothed toward the apex; cells subquadrate and short-rectangular, thick-walled, and minutely verruculose-striolate above, longer and thinner-walled below, especially toward the costa at base. Perichaetial leaves scarcely differentiated. Setae elongate, erect or flexuose-curved; capsules when moist suberect, subglobose, small-mouthed, and indistinctly striate, when dry somewhat curved and inclined to horizontal, ± ovoid, flattened at both ends, strongly furrowed; operculum small, short-conic or convex; peristome inserted somewhat below the mouth, double, the teeth smooth or very minutely papillose, lanceolate, with intermediate thickenings at back (the thickened cross-walls of the ventral plates not coinciding with the cross-walls of the dorsal plates); endostome consisting of a well-developed basal membrane and broad segments, the cilia none or very short and rudimentary.—The name means oblique or curved foot, making a not very apt reference to the more or less flexuose seta.

**Plagiopus oederiana** (Sw.) Limpr.—Plants 2-10 cm. high. Leaves 2-3.5 mm. long; upper cells about 9 $\mu$ wide, 1-2:1. Synoicous. Setae 7-18 mm. long; annulus none; operculum low-convex; peristome teeth smooth or very finely papillose, golden-brown or red-brown; endostome pale-brown, about 2/3 the length of the teeth, smooth or faintly papillose. Spores ellipsoidal, 20-26 $\mu$, coarsely papillose.—n = 7.

Conard, How to Know the Mosses, (ed. 2) fig. 111 (as *P. oederi*). Darlington, Mosses of Michigan, fig. 84 (as *P. oederi*). Grout, Mosses with Hand-lens and Microscope, fig. 104b, d, g (as *Bartramia oederi*), Moss Flora of North America 2: Pl. 67G (as *P. oederi*).—**Fig. 548-549.**

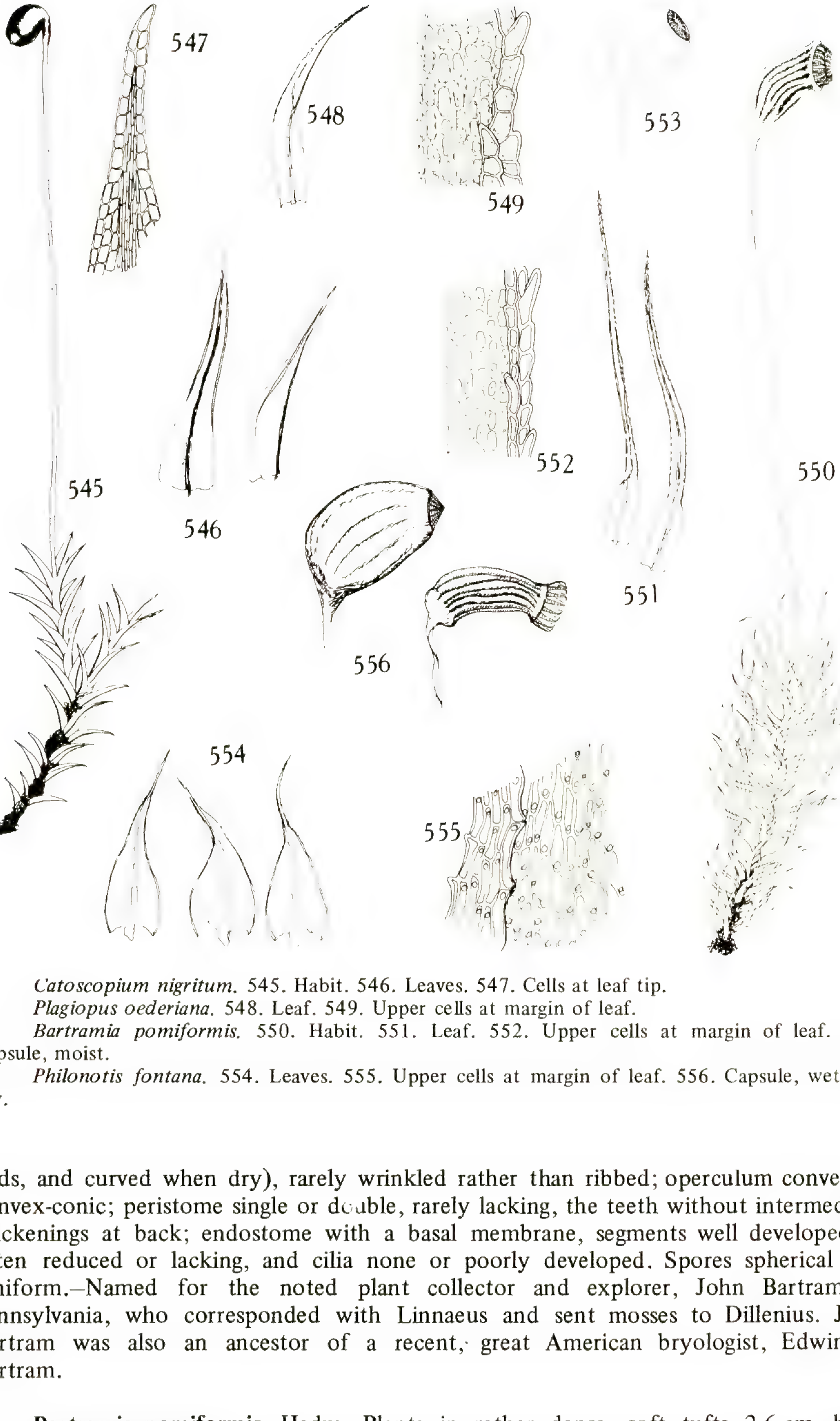
On damp, shaded cliffs or in crevices, sometimes on humus over boulders, generally calciphilous. Circumpolar; Hawaii; Greenland to Alaska and south to Virginia, Iowa, Colorado, and Oregon.

MACKINAC CO.—Mackinac Island.

Similar to *Bartramia pomiformis* but with leaves somewhat curved though scarcely contorted when dry and cells slightly roughened by verruculose striations but not papillose.

## 2. **Bartramia** Hedw.

Plants small to rather robust, in loose to dense, often rigid tufts, dull, green, yellowish, or glaucous above, yellow-brown and radiculose or tomentose below. Stems not triangular in section, with a cortex of small, firm cells. Leaves sometimes crisped when dry, gradually or abruptly narrowed from an erect, sometimes sheathing base to a linear-lanceolate or subulate point, toothed at the margins above and often at the back of the costa; costa prominent at back, vanishing below the apex to excurrent; upper cells in 2-3 layers (sometimes only at the margins), small, subquadrate to oblong-linear, firm-walled, papillose at the ends on both surfaces; lower cells long-rectangular to linear, pale, smooth, thin-walled. Setae usually elongate, straight or sometimes curved; capsules mostly inclined and asymmetric, subglobose, oblique at the mouth, ribbed (becoming deeply furrowed, contracted at the middle, flattened at the




*Catoscopium nigritum.* 545. Habit. 546. Leaves. 547. Cells at leaf tip.
*Plagiopus oederiana.* 548. Leaf. 549. Upper cells at margin of leaf.
*Bartramia pomiformis.* 550. Habit. 551. Leaf. 552. Upper cells at margin of leaf. 553. Capsule, moist.
*Philonotis fontana.* 554. Leaves. 555. Upper cells at margin of leaf. 556. Capsule, wet and dry.

ends, and curved when dry), rarely wrinkled rather than ribbed; operculum convex or convex-conic; peristome single or double, rarely lacking, the teeth without intermediate thickenings at back; endostome with a basal membrane, segments well developed or often reduced or lacking, and cilia none or poorly developed. Spores spherical and reniform.—Named for the noted plant collector and explorer, John Bartram of Pennsylvania, who corresponded with Linnaeus and sent mosses to Dillenius. John Bartram was also an ancestor of a recent, great American bryologist, Edwin B. Bartram.

**Bartramia pomiformis** Hedw.—Plants in rather dense, soft tufts 2-6 cm. high, light- or yellow-green or yellow-brown, sometimes ± glaucous, tomentose below. Leaves

± spreading and flexuose or crisped from an erect base when dry, loosely erect or erect-spreading when moist, 4-5.5 mm. long, linear-lanceolate, acuminate; margins revolute almost to the apex, bistratose and doubly serrate; costa shortly excurrent, serrate at back toward the apex; upper cells subquadrate and short-rectangular, about 1-2:1, thick-walled, unipapillose on both surfaces; basal cells pale, long-rectangular, rather thin-walled. Synoicous and autoicous (the perigonia next to the perichaetia). Setae 8-20 mm. long, erect-flexuose; capsules 1.5-2 mm. long, inclined to horizontal, globose to ovoid, deeply furrowed when dry; annulus none; operculum convex; peristome teeth inserted somewhat below the mouth, lanceolate, red-brown, very finely papillose, strongly barred at back; endostome pale-brown, shorter than the teeth, consisting of a well-developed basal membrane and broad segments. Spores spherical and ± ellipsoidal, brown, coarsely papillose, 20-24 $\mu$.—n = 8, 8+1; 2n = 16.

Conard, How to Know the Mosses, (ed. 2) fig. 89. Darlington, Mosses of Michigan, fig. 85. Grout, Mosses with Hand-lens and Microscope, Pl. 44 and fig. 104a, c, e, f, Moss Flora of North America 2: Pl. 68A-B (as *B. glaucoviridis* & *B. circinatula*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 24, (ed. 2) Pl. 28. Welch, Mosses of Indiana, fig. 111.—**Fig. 550-553.**

On moist, shaded soil of steep banks in woods and often on ledges, crevices, or faces of cliffs. Europe, Asia, Madeira, New Zealand; Greenland; Alaska to Oregon and Montana; Labrador to Manitoba, south to the Gulf States.

CHEBOYGAN CO.—Douglas Lake (at Polypody Bluff and on the campus of the Biological Station). EMMET CO.—Maple River dam. PRESQUE ISLE CO.—Lamprey Experiment Station.

This is the APPLE MOSS, rare here but common throughout most of eastern North America and often associated with *Aulacomnium heterostichum.* In addition to the apple-like capsules (characteristic of the family), the slender, crisped, and contorted leaves with papillose cells are distinctive.

In montane parts of the Upper Peninsula we have **Bartramia ithyphylla** Brid.: Leaves abruptly subulate from a broad, sheathing base, rigidly erect when dry; upper cells 2-3-stratose except at the margins; costa indistinct above and appearing to fill most of the subula; margins merely serrulate.

## 3. **Philonotis** Brid.

Plants small to moderately robust, usually in dense tufts, dull- or bright-, bluish- or whitish-green or yellowish, radiculose to tomentose. Stems forked or frequently whorled (below inflorescences). Leaves erect to spreading and sometimes secund, usually not much altered on drying, ovate to lanceolate, occasionally blunt but usually acuminate and narrowly acute; costa percurrent to excurrent; upper cells unistratose, oblong to linear or shortly rhomboidal, papillose at 1 or both ends or rarely smooth; lower cells usually larger and thinner-walled. Perigonia bud-like or larger and discoid with bracts abruptly narrowed from a broad, sheathing base, the paraphyses filiform-clavate; perichaetia with filiform paraphyses. Setae elongate, erect; capsules strongly inclined to horizontal, subglobose with a short neck, asymmetric, ribbed (furrowed, usually contracted at the middle, and flattened at the base when dry); operculum convex-conic, blunt or mammillate; peristome teeth dark- or red-brown, densely papillose; endostome consisting of keeled, vertically papillose-striate segments from a high basal membrane and cilia rudimentary to fairly well-developed. Spores reniform, orange or brown, densely papillose.—The name means loving moisture.

Leaves rather abruptly acuminate from a ± broad base; upper leaf cells papillose at the lower ends on the outer surface, at the upper ends on the inner surface — 2. *P. fontana*

Leaves lanceolate, gradually acuminate from a narrow base; upper cells papillose only at the upper ends — 1. *P. marchica*

1. **Philonotis marchica** (Hedw.) Brid.–Plants in loose or dense, bright-green tufts 2-5 (sometimes 8) cm. high. Leaves erect-spreading to spreading, not or slightly curved, 1.3-2.3 mm. long, lanceolate, acuminate, acute; margins serrulate nearly to the base, plane or nearly so; costa excurrent; upper cells linear, papillose at the upper ends. Dioicous; perigonia discoid. Setae 2-4 cm. long; capsules 2-2.5 mm. long. Spores 20-26 $\mu$.

Grout, Moss Flora of North America 2: Pl. 69G. Welch, Mosses of Indiana, fig. 112.

On soil in wet habitats, roadbanks, near springs, etc. Circumpolar; British Columbia to Arizona and widespread in eastern North America from southern Canada to the Gulf of Mexico.

CHEBOYGAN CO.–On a roadbank northeast of Burt Lake (near Livingston Bog).

The leaf margins plane or nearly so and the leaf cells papillose only at the upper ends are sufficient to distinguish this uncommon species locally. On Sugar Island in nearby Chippewa County, however, **Philonotis capillaris** Lindb. *ex* C. J. Hartm. is found. It has shorter leaves (0.5-1.1 mm. long), with oblong cells (2-4:1).

2. **Philonotis fontana** (Hedw.) Brid.–Plants in dense, bright-green or yellowish tufts 3-10(16) cm. high (pale or whitish and noticeably red-tinged when growing). Stems red. Leaves erect, erect-spreading, or ± falcate-secund, 1.1-2 mm. long, ovate-lanceolate, ± abruptly acuminate; margins serrulate, revolute in the lower ½ or more; costa short- to long-excurrent; upper cells oblong-linear or linear, papillose at the lower ends on the outer surface and at the upper ends on the inner surface. Dioicous; perigonia discoid. Setae 2-4 cm. long; capsules 2-3 mm. long. Spores 24-30 $\mu$.–n = 6.

Conard, How to Know the Mosses, (ed. 2) fig. 87. Darlington, Mosses of Michigan, fig. 86. Grout, Mosses with Hand-lens and Microscope, fig. 103, Moss Flora of North America 2: Pl. 69A, F, 70A-E (including varieties). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 25, (ed. 2) Pl. 29. Welch, Mosses of Indiana, fig. 113, 114 (as var. *pumila*), 115 (as var. *falcata*).–**Fig. 554-556.**

On soil or rock in wet, often seepy places, on banks of ditches, around springs, along brooks, etc., usually in the open. Circumpolar; widespread in North America south to northern Mexico.

CHEBOYGAN CO.–Gorge of Carp Creek, Iron Bridge, Reeses Bog, Burt Lake, Cheboygan, Point Nipigon. EMMET CO.–Wilderness State Park, Cecil Bay, Conway Bog, Ramona Beach. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, Epoufette. PRESQUE ISLE CO.–Mast Point, Hammond Bay, Evergreen Beach.

This is a species of great variability and, as Dixon said, "No good purpose seems served by giving varietal names to the numberless variations which occur." Flowers, after "spending a lifetime with the genus," wrote me shortly before his death that he would no longer recognize any of the sterile varieties included in his revision of the genus in Grout's *Moss Flora of North America.*

The white or bluish-glaucous color of the leaves, when fresh, contrasts with the red stems. (*Pohlia wahlenbergii,* of similar habitats, is softer and more delicate and does not form compact tufts.) The leaf cells have papillae on both ends (at the lower end on the outer surface and the upper end on the inner), a feature that will usually suffice to distinguish this, the most common species of a bad genus.

## ORTHOTRICHACEAE

Plants small to fairly robust, dull, green, brown, yellow-brown, or reddish, in small cushions or extensive tufts or mats. Stems erect or erect-ascending and generally

forked or long and creeping with numerous erect-ascending and often forked branches, radiculose below or along the creeping stems. Leaves crowded in many rows, often curled or spirally contorted when dry, ovate- to ovate-lanceolate or oblong-lanceolate, mostly acute, often apiculate, rarely awned, usually keeled, mostly entire; costa single, ending somewhat below the apex to excurrent; upper cells mostly rounded-hexagonal, occasionally elongate, firm- or thick-walled, green, usually uni- or pluripapillose on both surfaces, sometimes bulging to mammillose, rarely smooth; lower cells mostly elongate-rectangular to linear, often incrassate, hyaline or yellowish. Perichaetial leaves rarely much differentiated. Setae mostly terminal, mostly erect, very short to elongate, sometimes roughened; capsules immersed to exserted, erect and symmetric, broadly ovoid to oblong-cylindric, sometimes pyriform, often ribbed; annulus usually present; operculum rostrate; stomata present, sometimes immersed; peristome usually double, sometimes single, rarely lacking, the teeth 16 but often united or in pairs, sometimes completely united into an irregular membrane, lanceolate, usually papillose or variously striolate, sometimes with a fragmentary pre-peristome; endostome often reduced or lacking, the basal membrane (sometimes lacking) low, the segments linear to lanceolate, 8 or 16, alternating with the teeth, cilia none. Calyptrae cucullate or mitrate, naked or hairy, smooth or plicate.

1. Calyptrae cucullate; brood-bodies common, on radicles or in leaf axils; leaf margins plane; leaf cells short nearly to the insertion ..... 3. *Zygodon*
1. Calyptrae mitrate; brood-bodies, if present, on leaves; leaf margins mostly revolute; leaf cells elongate below
 2. Leaves bordered at base by 1-several rows of pale, short cells with thickened cross-walls, the inner basal cells linear, yellowish, thick-walled, usually in somewhat radiating rows; capsules with a rather long, tapered neck, ± spindle-shaped; stomata superficial, restricted to the neck ..... 2. *Ulota*
 2. Leaves not bordered at base, the inner basal cells not as above; capsules short-necked, not spindle-shaped; stomata superficial or immersed, not restricted to the neck ..... 1. *Orthotrichum*

## 1. **Orthotrichum** Hedw.

Plants small to fairly robust, typically in small tufts, mostly dark-green or brownish, dull, radiculose at base, erect or ascending, forked or fasciculately branched. Leaves crowded, rarely much contorted when dry, ovate-lanceolate to oblong-lanceolate, acute or rarely blunt or rounded, very rarely piliferous, mostly ± keeled, nearly always revolute at the margins, generally from the base nearly to the apex; costa rather strong, usually ending near the apex; upper cells green, ± rounded, thick-walled, incrassate, usually pluripapillose on both surfaces; lower cells rectangular (or subquadrate) to linear, not or somewhat incrassate, hyaline or pellucid, sometimes shorter at the margins but not forming a hyaline border. Autoicous or rarely dioicous; perichaetial leaves only slightly differentiated. Setae terminal, straight, very short to fairly long; capsules immersed to exserted, oblong-ovoid to subcylindric from a ± tapered neck, smooth or 8- or 16-ribbed (on drying often becoming deeply furrowed and sometimes strongly contracted below the mouth), the ribs corresponding to colored bands of exothecial cells; annulus none or poorly differentiated and persistent; operculum stoutly rostrate from a convex or conic base; stomata superficial or immersed, not restricted to the neck; peristome mostly double but sometimes single and rarely lacking, usually with 16 broadly lanceolate teeth, sometimes approximate or joined in pairs, occasionally with a pre-peristome, and 8 or 16 filiform segments alternating with the teeth. Spores spherical, brown, papillose, Calyptrae campanulate-mitrate, covering most of the urn, usually ± plicate, naked or hairy, smooth or rarely papillose.—The generic name refers to the straight (upright) hairs on the calyptrae of many of the species (but sometimes sparse). The stomata have taxonomic importance in this genus. Species with superficial stomata have guard cells at the

surface, but those with immersed stomata have guard cells sunken in chambers partially or almost completely roofed over by projections of surrounding cells. Those with superficial stomata have a haploid chromosome number of six; those with immersed stomata have (with one known exception) 11. Confusion with *Grimmia* can be avoided by referring to the discussion of that genus, which belongs to the Haplolepideae rather than the Diplolepideae.

One of the few attempts to analyze phylogenetic relationships and the direction of evolution was made by Vitt (*The Family Orthotrichaceae (Musci) in North America,* 1970) using the "Wagner Tree" method. Koponen's work on *Mnium* (Ann. Bot. Fenn. 5: 117-151. 1968) and Seki's on the Sematophyllaceae (Jour. Sci. Hiroshima Univ., ser. B., div. 2, 12: 1-80. 1968) also attempt objective analysis of evolutionary relationships.

Techniques for the evaluation of characters distinguishing species are exemplified by Briggs (New Phytol. 64: 366-386. 1965), Greig-Smith (Trans. Brit. Bryol. Soc. 2: 458-469. 1954), Iwatsuki (Bryol. 61: 68-78. 1958), Lefebvre & Lennes (Taxon 18: 291-299. 1969), Koponen (Ann. Bot. Fenn. 4: 67-73. 1967), Rahman (Jour. Bryol. 7: 169-179. 1973), Redfearn (Bryol. 59: 256-262. 1956), Smith (Trans. Brit. Bryol. Soc. 6(1): 56-68. 1970), and Suzuki (Jap. Jour. Bot. 16: 227-268. 1958).

1. Leaves with erect margins and broad, blunt to rounded tips — 1. *O. obtusifolium*
1. Leaves with recurved margins and narrow, blunt or acute tips
 2. Stomata superficial
  3. Capsules oblong-cylindric, strongly ribbed and moderately contracted below the mouth when dry; segments rather stout, smooth or nearly so — 2. *O. sordidum*
  3. Capsules narrowly cylindric, smooth or rarely obscurely plicate, not contracted below the mouth; segments vey stout, densely papillose — 3. *O. speciosum* var. *elegans*
 2. Stomata immersed
  4. Plants growing on rock; capsules shortly exserted; peristome teeth erect or ± spreading when dry — 4. *O. anomalum*
  4. Plants on bark; capsules immersed to emergent; peristome teeth mostly recurved when dry
   5. Capsules small and delicate, straw-colored, wrinkled or sometimes lightly ribbed and not at all contracted below the mouth when dry; exothecial cells obscurely or sometimes rather clearly differentiated in bands 4 cells wide; peristome teeth erect (or occasionally becoming ± reflexed with age), soon splitting into 16 small and irregular divisions; endostome none — 8. *O. pusillum*
   5. Capsules darker, not delicate, distinctly ribbed and usually ± contracted below the mouth when dry; exothecial cells well differentiated; peristome teeth 8 or eventually becoming split into 16, but the divisions not particularly small or irregular; endostome segments present
    6. Leaves apiculate and sometimes sparsely toothed at the tip; cells surrounding stomata not notably jutting or otherwise differentiated — 7. *O. pumilum*
    6. Leaves not apiculate or toothed at the apex; cells surrounding stomata clearly differentiated
     7. Capsules strongly ribbed and very strongly contracted below the mouth when dry; ribs about 6-8 cells wide and typically dark-brown; cells surrounding stomata projecting horizontally; peristome teeth 8 and usually not splitting into 16 divisions — 5. *O. stellatum*
     7. Capsules rather narrowly and distantly ribbed and not or slightly contracted below the mouth when dry; ribs about 4 cells wide and pale-brown; cells surrounding stomata jutting steeply or almost vertically; peristome teeth 8, regularly splitting into 16 divisions — 6. *O. ohioense*

1. **Orthotrichum obtusifolium** Brid.—Plants in dense, dull, dark-green to brown or yellowish tufts 5-10(25) mm. high. Leaves about 1.5-2 mm. long, erect-appressed, scarcely altered when dry, ovate (or rarely lanceolate), blunt or rounded at apex, concave, with margins erect and entire, usually bearing abundant small, green or red-brown, shortly cylindric brood bodies 4-5 cells long on the upper surface of the lamina (and sometimes on both surfaces); costa slender, ending well below the apex, narrowly channeled; upper cells isodiametric, 13-18 $\mu$ wide, strongly thickened at the

corners, green, unipapillose on both surfaces; lower cells rectangular, 2-4:1, with firm walls often ± pitted, pale and smooth, Dioicous. Seta less than 0.5 mm. long; urn immersed to emergent, about 2 mm. long including the neck (about as long as the spore sac), elongate-pyriform, cylindric and ± strangulate when dry and empty, strongly 8-plicate, dark-brown; exothecial cells clearly differentiated along the ribs; stomata superficial; peristome double, the teeth fused together in 8 pairs, red or orange-red, densely papillose or irregularly papillose-striolate, reflexed when dry, the segments 8, brownish-yellow, smooth or striolate, well developed, of 2 rows of cells, erect. Spores 16-18 $\mu$. Calyptra not plicate, naked, papillose throughout.—n = 11.

Conard, How to Know the Mosses, (ed. 2) fig. 67. Grout, Mosses with Hand-lens and Microscope, fig. 91. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 63. Welch, Mosses of Indiana, fig. 100.—**Fig. 557-562.**

On the bark of trees (commonly on poplars), rarely on old fence rails. Europe; Japan; Yukon to Labrador and Newfoundland, south to California, Arizona, the Great Lakes, and North Carolina.

CHEBOYGAN CO.—Reeses Bog, Carp Creek, Smiths Bog, Burt Township Hall, Riggsville, Passino School, Mud Lake. EMMET CO.—Alanson, Levering, Larks Lake, Pellston Dunes, Pellston, west branch of Maple River, Pellston Hills, Stutsmanville, Middle Village, Wycamp Lake. MACKINAC CO.—Bois Blanc Island, Mackinac Island, Gros Cap, Caffey Corner, Hendricks. PRESQUE ISLE CO.—Lamprey Experiment Station, Loon Lake, Onaway.

Perhaps our most common *Orthotrichum,* unlike all the others because of the leaves with rounded-obtuse apices and erect margins.

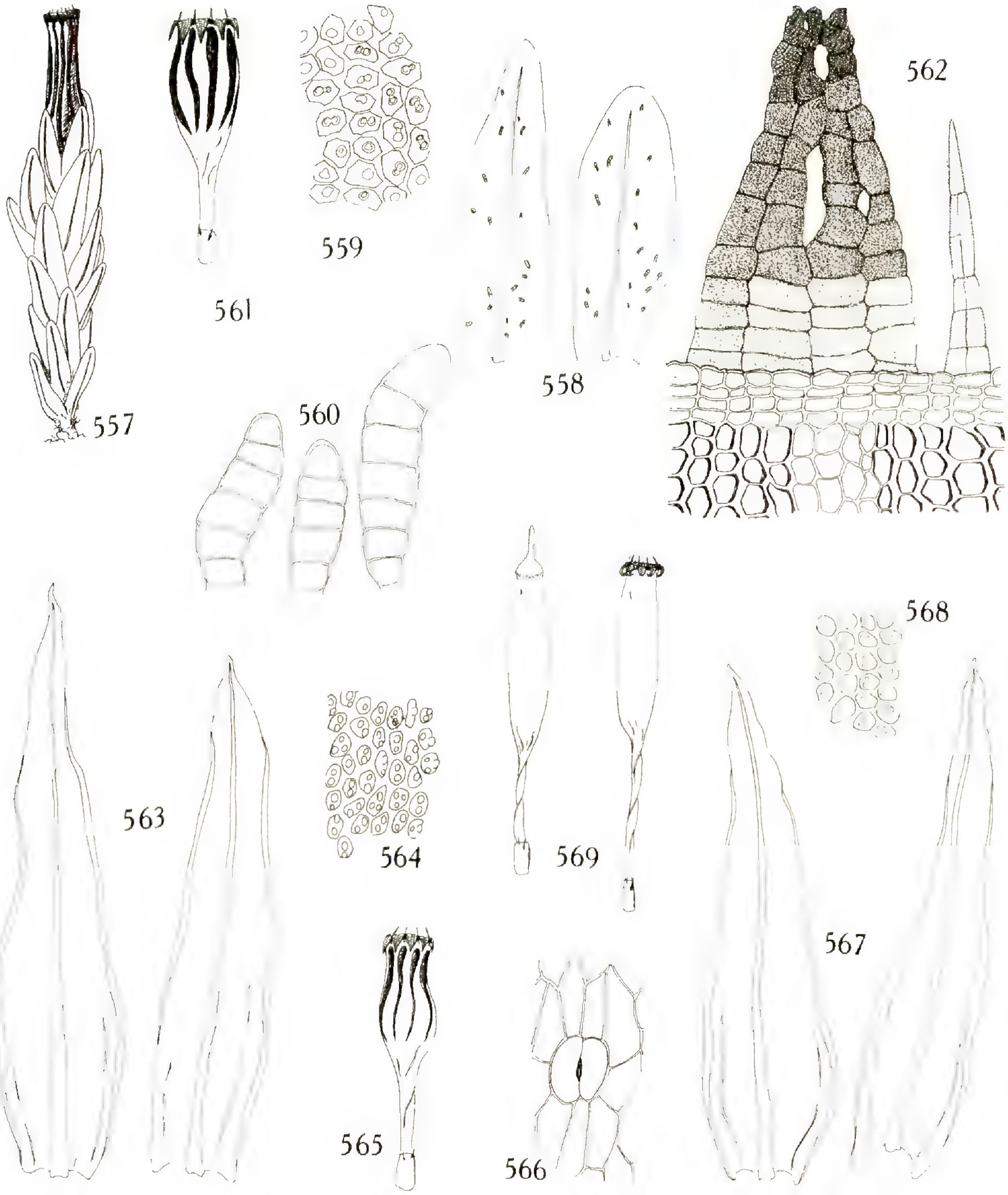
2. **Orthotrichum sordidum** Sull. & Lesq. *ex* Aust.—Plants in small, dense, dark-green to yellow-brown cushions about 6-10 mm. high. Leaves erect and slightly contorted when dry, erect-spreading when moist, 1.5-3 mm. long, oblong- or ovate-lanceolate, acute; margins entire, revolute nearly to the apex; costa ending slightly below the apex; upper cells 8-13 $\mu$, irregularly rounded and rounded-hexagonal, incrassate, pluripapillose on both surfaces; basal cells rectangular, moderately incrassate and pitted. Autoicous. Setae up to 2.5 mm. long; capsules emergent to shortly exserted, 1-1.8 mm. long, yellow-brown, oblong-cylindric and tapered at the neck, moderately constricted below the mouth and strongly 8-ribbed when dry and empty; exothecial cells moderately differentiated along the ribs; stomata superficial; peristome teeth orange-brown, strongly reflexed when dry, fused in 8 pairs (occasionally becoming ± split), densely and finely papillose, cancellate at the apex; segments 8, brownish-yellow, relatively stout (consisting of 2 rows of cells), smooth or ± obscurely papillose. Spores 17-24 $\mu$. Calyptra plicate, hairy, smooth.—n = 6.

Grout, Mosses with Hand-lens and Microscope, Pl. 39. Welch, Mosses of Indiana, fig. 99.—**Fig. 563-566.**

On the bark of trees. Newfoundland and Nova Scotia to Ontario and south to New England and the Great Lakes; Japan.

CHEBOYGAN CO.—Hermits Bog, Gorge of Carp Creek, Colonial Point, Livingston Bog, Riggsville, Mud Lake, Cheboygan, Mill Creek, Mud Creek, Black Lake. EMMET CO.—Brutus, Pellston Dunes, Pellston, Pellston Hills, Middle Village, Good Hart, Wycamp Lake. MACKINAC CO.—Bois Blanc Island, Mackinac Island, Gros Cap, Epoufette, Hendricks. PRESQUE ISLE CO.—Onaway, Rainy River Falls, Posen.

The capsules are strongly ribbed and somewhat contracted below the mouth when dry, and the peristome teeth are orange and somewhat latticed at their tips. This is our only species of the superficial stomate group with distinctly ribbed or strangulate capsules.




*Orthotrichum obtusifolium*. 557. Habit. 558. Leaves. 559. Upper cells of leaf. 560. Brood-bodies. 561. Capsule, dry. 562. Portion of peristome.

*Orthotrichum sordidum*. 563. Leaves. 564. Upper cells of leaf. 565. Capsule, dry. 566. Stomate.

*Orthotrichum speciosum* var. *elegans*. 567. Leaves. 568. Upper cells of leaf. 569. Capsules, dry.

3. **Orthotrichum speciosum** Nees *ex* Sturm var. **elegans** (Schwaegr. *ex* Hook. & Grev.) Warnst.—Plants 5-10, rarely 20 mm. high, dark-green or sometimes brownish. Leaves loosely erect when dry, erect-spreading to spreading with recurved tips when moist, lanceolate, acuminate, acute; margins revolute nearly to the apex; costa ending at or near the apex; upper cells about 7-11 $\mu$ wide, irregularly rounded and shortly oval, incrassate, pluripapillose. Autoicous. Setae short; capsules emergent to shortly exserted, about 1.2-1.7 mm. long, narrowly cylindric, smooth (or rarely faintly plicate when dry and empty); exothecial cells not differentiated in longitudinal bands; stomata

superficial; peristome teeth 8, recurved when dry, pale orange-brown, densely papillose; endostome segments 8, incurved when dry, stout and about as long as the teeth, densely papillose. Spores 13-26 $\mu$. Calyptrae hairy, smooth.—n = 6, 12, 12+1, 13 (all in *O. speciosum* var. *speciosum*).

Grout, Moss Flora of North America 2: Pl. 50D (as *O. elegans*).—**Fig. 567-569.**

On trees, rarely on old logs, fence rails, or rock. Alaska to Newfoundland, south to Oregon, Michigan, and New York (common in the East but usually replaced by *O. speciosum* in its robust typical form in the West).

CHEBOYGAN CO.—Reeses Bog, Carp Creek, Douglas Lake, Riggsville, Cheboygan, Grass Bay, Mullett Lake. EMMET CO.—Levering, Brutus, Pellston Dunes, Pellston, Pellston Hills, Five Mile Creek, Wycamp Lake, Cecil Bay, Wilderness State Park, Big Stone Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island, McKays Creek, McNamara Pond. PRESQUE ISLE CO.—Lamprey Experiment Station, Rainy River Falls, Clinton Lake, Loon Lake.

The var. *elegans* is recognized by its narrowly cylindric, smooth capsules, with yellow-brown peristome teeth strongly recurved (like the handle of a mug) when dry and pale, stout, papillose segments incurved when dry. (**Orthotrichum speciosum** has been found in its typical form in Keweenaw Co. and also on Sugar Island in Chippewa Co. It is larger, with broader, obscurely ribbed capsules.)

4. **Orthotrichum anomalum** Hedw.—Plants in rigid, dark- or blackish-green to brownish cushions about 10-20 mm. high. Leaves erect and scarcely contorted when dry, erect-spreading when moist, 2-3 mm. long, ovate- or oblong-lanceolate, broadly (or rarely slenderly) acute and blunt; margins entire, revolute nearly to the apex; costa ending slightly below the apex; upper cells about 10-11 $\mu$ wide, irregularly rounded-hexagonal, ± incrassate, pluripapillose on both surfaces; lower cells rectangular, smooth, pale, somewhat incrassate. Autoicous. Setae 2.5-3 mm. long; capsules 1.5-2 mm. long, barely to shortly exserted, oblong-cylindric, becoming tapered at the neck, constricted above the middle and strongly furrowed when dry (with 8 strong ribs usually alternating with 8 less prominent ones), light- to chestnut-brown; annulus none; operculum stoutly and bluntly rostrate; exothecial cells differentiated along the ribs; stomata immersed; peristome teeth at first fused in pairs, later 16, erect or spreading when dry, yellow-brown, faintly to distinctly sinuose-striolate, often with fragmentary pre-peristome thickenings at the base; endostome consisting of 8 irregular, smooth cilia, often rudimentary or lacking. Spores 10-16 $\mu$, papillose. Calyptrae smooth, sparsely to moderately hairy.—n = 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 71a-c. Darlington, Mosses of Michigan, fig. 88. Grout, Mosses with Hand-lens and Microscope, fig. 86.—**Fig. 570-572.**

On rocks, usually if not always calcareous. Europe; Japan; Mexico and Haiti; Alberta to Nova Scotia, south to Oregon and Arizona, Colorado, Iowa, and Virginia.

EMMET CO.—Pellston Hills, Big Stone Bay. MACKINAC CO.—Mackinac Island, McKays Creek, Bush Bay.

Unmistakable by its habitat, on rock, and its exserted capsules with immersed stomata. *Orthotrichum anomalum* presents no problems locally, but some characters useful in cases of doubt are the faint, sinuous markings on the peristome teeth and the pre-peristome fragments attached to the outer surface near the base of the teeth. The intermediate ribs on the capsule are distinctive, though not always present. Our only species growing on rock, *Orthotrichum anomalum* is superficially similar to *Ulota hutchinsiae* (Sm.) Hamm., which prefers acid, siliceous rocks over limestone. (It has

been found once in our area, perhaps on an erratic boulder, and it occurs on Sugar Island in nearby Chippewa Co. It is nearly black except at the growing tips and grows in extensive, loose colonies. Its capsules are gradually tapered to a long neck, the peristome teeth are reflexed, and the stomata are superficial. Also the basal leaf cells have, to some extent, the radiating pattern typical of *Ulota,* with cells in rows fanning out from the base toward the shoulders.)

5. **Orthotrichum stellatum** Brid.–Small, yellow-brown plants about 3-5 mm. high. Leaves rather rigid, erect and scarcely contorted when dry, spreading or erect-spreading when moist, 1.8-2.3 mm. long, oblong-lanceolate, blunt or bluntly acute; margins revolute nearly to the apex, entire; costa ending at or near the apex; upper cells 9-13 $\mu$ wide, irregularly rounded, moderately incrassate, low-papillose. Brood-bodies pale-brown, cylindric or shortly filamentous, occasional on leaves. Autoicous. Capsules emergent, 1.5-2 mm. long, oblong-cylindric when moist, narrower, deeply 8-ribbed, strongly strangulate, and tapered to the seta when dry, chestnut-brown; exothecial cells clearly differentiated in bands ± 8 cells wide; stomata immersed, with surrounding cells clearly differentiated and projecting nearly horizontally; peristome teeth 8 (rarely split), reflexed when dry, densely and finely papillose; segments 8, linear, of 2 rows of cells, smooth. Spores 11-18 $\mu$. Calyptrae plicate, naked or sometimes ± hairy, smooth.

Grout, Mosses with Hand-lens and Microscope, fig. 88 (as *O. strangulatum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 15 (as *O. braunii*), (ed. 2) Pl. 19. Welch, Mosses of Indiana, fig. 102.–**Fig. 573-575.**

On trees, rarely on logs, stumps, or fence rails. Germany and Scotland; Newfoundland to Wisconsin and Iowa, south to Arkansas and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Carp Creek, Riggsville. EMMET CO.–Alanson, Wycamp Creek, Middle Village. PRESQUE ISLE CO.–Belknap.

The specific epithet refers to the peristome teeth which may spread like the rays of a star when dry. The species has been nomenclaturally confused with **O. strangulatum** P.-Beauv. (fig. 576-578), a limestone species with strangulate capsules and 16, rather than eight peristome teeth.

The conspicuously strangulate capsules with straight, heavy, chestnut-brown ridges which become contiguous on complete contraction are unmistakable. In *O. pumilum,* the species most likely to be confused with *O. stellatum,* the capsules are fairly strangulate and the ribs dark-brown and prominent, but on contraction of the suboral region they do not become contiguous, and they often seem slightly spiraled. Of course, the apiculate and even denticulate apices of many leaves in *O. pumilum* are distinctive. In *O. ohioense,* the capsules are at most only slightly strangulate, and the ribs, though distinct, are pale, yellow-brown, narrow, and widely spaced.

**Orthotrichum pallens** Bruch *ex* Brid. (fig. 579-581) is a western species found disjunctively in nearby Alpena County and in the Upper Peninsula in Keweenaw County. It is autoicous, as most *Orthotricha* are, but has the perigonia at the ends of short branches rather than in leaf axils near the perichaetia. It has strongly ribbed, strangulate capsules with slightly to distinctly immersed stomata, peristome teeth united in eight pairs, 16 slender endostome segments, and a naked calyptra. A related species, also disjunct from a broad western range in Keweenaw County, **O. alpestre** Hornsch. *ex* BSG, has axillary perigonia below the perichaetia, eight stout segments, and a somewhat hairy calyptra (with papillae on the hairs).

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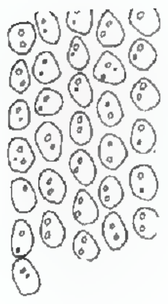

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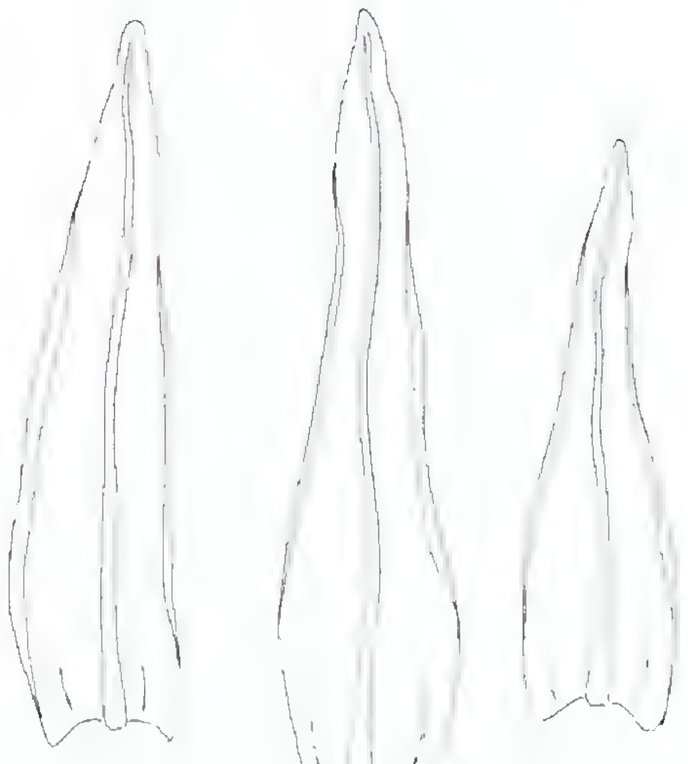

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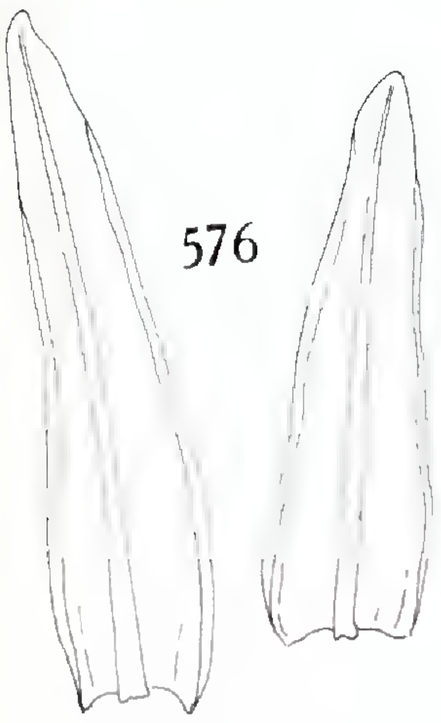

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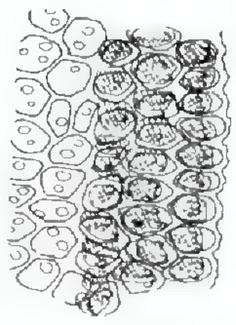

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*Orthotrichum anomalum*. 570. Leaves. 571. Upper cells of leaf. 572. Capsules, dry.
*Orthotrichum stellatum*. 573. Leaves. 574. Upper cells of leaf. 575. Capsule, dry.
*Orthotrichum strangulatum*. 576. Leaves. 577. Upper cells at leaf margin. 578. Capsules, dry.
*Orthotrichum pallens*. 579. Leaves. 580. Upper cells of leaf. 581. Capsules, dry.

6. **Orthotrichum ohioense** Sull. & Lesq. *ex* Aust.—Small, brownish plants up to 10 mm. high. Leaves rigid, erect when dry, erect-spreading when moist, 2-2.5 mm. long, oblong-lanceolate, bluntly acute; margins revolute nearly to the apex, entire; costa ending slightly below the apex; upper cells 9-12 $\mu$ wide, irregularly rounded or transversely oval, rather evenly incrassate, rather obscurely papillose on both surfaces. Brood-bodies apparently lacking. Autoicous. Setae about 0.7-0.8 mm. long; capsules emergent, oblong-cylindric, pale-brown, narrowly and distantly ribbed and not or only slightly constricted below the mouth when dry and empty; exothecial cells differentiated in longitudinal bands 4 cells wide; stomata at middle of the capsule, immersed because of greatly differentiated, thick-walled cells jutting steeply or almost vertically

over the stomatal chamber; peristome single, the teeth reflexed when dry, 8, soon splitting into 16 small, lanceolate divisions, densely and finely papillose, reflexed when dry, sometimes with inconspicuous pre-peristome thickenings at base; segments 8, smooth; Spores 15-21 $\mu$. Calyptrae plicate, hairy, smooth.—n = 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 73f-g. Grout, Mosses with Hand-lens and Microscope, fig. 87. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 15, (ed. 2) Pl. 19. Welch, Mosses of Indiana, fig. 103.—**Fig. 582-585.**

On bark of trees. Nova Scotia to Michigan, south to South Carolina, Mississippi, and Arkansas.

CHEBOYGAN CO.—Reeses Bog, Gorge of Carp Creek. EMMET Co.—Middle Village. MACKINAC CO.—Hendricks.

A species commonly misunderstood but distinguished by pale capsules with narrow and remote but fairly well-marked ribs, 8 peristome teeth becoming split into 16 small, pale divisions, and stomatal chambers covered by greatly differentiated cells jutting almost vertically outward.

7. **Orthotrichum pumilum** Sw.—Small, dark- or blackish-green plants. Leaves erect when dry, spreading when moist, typically rather soft, about 2 mm. long, ovate-lanceolate, obtuse or acute, apiculate or slightly toothed at the extreme apex; margins revolute nearly to the apex; costa ending near the apex; upper cells 13-20 $\mu$, usually rather pellucid, rounded because of ± thickened corners, sometimes ± broader than long. Brood-bodies occasional on the leaves. Autoicous. Capsules emergent, about 1.5 mm. long, oblong-ovoid, strongly 8-ribbed and strangulate (sometimes strongly so) when dry, dark-brown; exothecial cells clearly differentiated in bands ± 8 cells wide (cells of ribs not greatly incrassate below the suboral zone as in *O. stellatum*); stomata immersed, the cells surrounding the stomatal cavities usually not jutting or notably differentiated; peristome teeth 8, reflexed, brownish, densely papillose; segments 8, yellow, smooth. Spores 13-17 $\mu$. Calyptrae plicate, naked or ± hairy.—n = 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 73a-e. Grout, Mosses with Hand-lens and Microscope, fig. 89 (as *O. schimperi*). Welch, Mosses of Indiana, fig. 104.—**Fig. 586-589.**

On trees. Germany and Austria; New England to Ontario, South Dakota, and Nebraska, south to North Carolina and Louisiana.

CHEBOYGAN CO.—Riggsville, Mud Lake, Passino School. EMMET CO.—Brutus, Pellston, Maple River, Pellston Hills, Five Mile Creek. MACKINAC CO.—Hendricks.

Known by apiculate upper and perichaetial leaves and strongly ribbed capsules which may be more or less strangulate (but the ribs are not completely drawn together as in *O. stellatum*).

8. **Orthotrichum pusillum** Mitt.—Small, dark- or blackish-green plants about 2 or 3 mm. high, scattered or loosely tufted. Leaves loosely erect when dry, erect-spreading when moist, 1.5-2.5 mm. long, oblong-lanceolate, bluntly acute; margins revolute nearly to the apex, entire (except for irregular denticulations at the apex of perichaetial leaves); costa ending slightly below the apex; upper cells about 11-13 $\mu$ wide, rounded to transversely oval, incrassate, pluripapillose on both surfaces. Brood-bodies sometimes produced on the leaves. Autoicous. Setae about 0.8-1 mm. long; capsules immersed to emergent, 1-1.75 mm. long, oblong-cylindric, delicate and thin-walled, somewhat wrinkled to lightly 8-plicate and not at all constricted below the mouth when dry and

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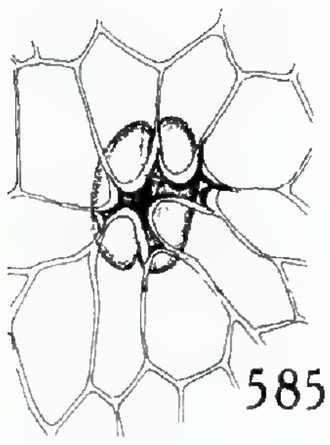
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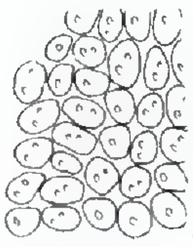
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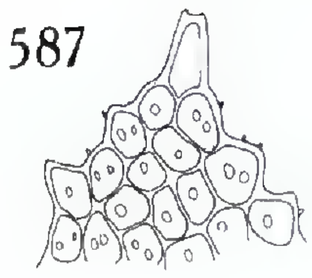
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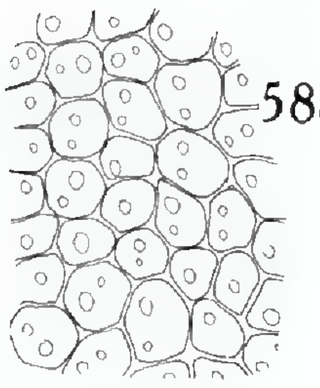
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*Orthotrichum ohioense.* 582. Leaves. 583. Upper cells of leaf. 584. Capsule, dry. 585. Stomate.

*Orthotrichum pumilum.* 586. Leaves. 587. Cells at leaf tip. 588. Upper cells of leaf. 589. Capsule, dry.

*Orthotrichum pusillum.* 590. Leaves. 591. Upper cells of leaf. 592. Capsule, dry.

empty, straw-colored; exothecial cells obscurely to rather distinctly differentiated in bands 4 cells wide; stomata immersed, the surrounding cells not particularly jutting or greatly differentiated; peristome teeth erect or sometimes becoming reflexed with age, soon becoming split into 16 small, irregular divisions, pale-brown, densely and finely papillose, often opaque; endostome none. Spores 13-18 $\mu$. Calyptra plicate, smooth, naked.—n = 11.

**Fig. 590-592.**

On bark of trees. Throughout the eastern United States.

CHEBOYGAN CO.—Riggsville, Passino School. EMMET CO.—Levering, Cross Village, Middle Village, Ramona Beach. MACKINAC CO.—Hendricks. PRESQUE ISLE CO.—Clinton Lake.

Among the species with immersed stomata, this one is distinctive because of small, delicate, pale, somewhat wrinkled to obscurely plicate capsules with the peristome becoming split into 16 small and irregular divisions which are recurved rather than reflexed.

## 2. **Ulota** Mohr *ex* Web.

Relatively small plants usually in small tufts, green, yellowish, or brownish above, dark-brown to blackish and ± radiculose below. Stems erect, forked. Leaves crowded,

mostly crisped and contorted when dry, lanceolate or linear-lanceolate from a broader, ± concave base, sharply to bluntly acute, ± keeled; margins usually ± revolute along the middle (especially when dry); costa percurrent or nearly so; upper cells rounded or elliptic, thick-walled, mostly papillose; cells of the sheathing base linear, yellowish, very thick-walled and sometimes porose, usually smooth, 1 or more marginal rows short and pale with thickened cross-walls. Perichaetial leaves not or slightly differentiated. Setae terminal, straight, ± elongate; capsules exserted, erect and symmetric, cylindric, fusiform, or narrowly urceolate, with a relatively long, tapering neck, 8-ribbed (or merely puckered at the mouth); annulus none; operculum stoutly rostrate from a convex or convex-conic base; exothecial cells differentiated along the ribs; stomata superficial, restricted to the neck; peristome mostly double, the teeth 16, often united in pairs, lanceolate; segments of endostome 8 or rarely 16 (sometimes lacking), linear. Calyptrae mitrate, deeply lobed, ± hairy.—*Ulota* means something curled and refers in this case to the crisped leaves of some species of the genus.

1. Capsules pyriform, smooth except at the puckered mouth — 1. *U. coarctata*
1. Capsules oblong-cylindric to fusiform, plicate
  2. Plants saxicolous; leaves slightly curved but scarcely crisped when dry, 1.7-2 mm. long; neck of capsules not clearly delimited; spores 9-14 μ — 3. *U. hutchinsiae*
  2. Plants corticolous; leaves strongly crisped when dry, 2-3 mm. long; capsules with a long, tapered neck; spores 18-24 μ — 2. *U. crispa*

1. **Ulota coarctata** (P.-Beauv.) Hamm.—Plants yellow-green to brown. Leaves erect and not or slightly contorted when dry, erect-spreading when moist, 1.5-2.5 mm. long, lance-acuminate from a short, concave base, acute; margins entire, narrowly revolute along the middle; costa ending somewhat below the apex; upper cells smooth or indistinctly papillose on both surfaces, rounded or elliptic, about 7 × 7-9 μ. Autoicous. Setae 3-4 mm. long; capsules 1.5-2.2 mm. long, pyriform, long-necked, strongly puckered by 8 short ribs and nearly closed at the mouth when dry; peristome teeth at first fused in 8 pairs, later 16, not recurved when dry, densely papillose; segments 8, very short and rudimentary. Spores 17-22 μ, ellipsoidal, papillose. Calyptrae densely pilose.—n = 9+1.

Conard, How to Know the Mosses, (ed. 2) fig. 65f (as *U. ludwigii*). Grout, Mosses with Hand-lens and Microscope, fig. 84 (as *U. ludwigii*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 15, (ed. 2) Pl. 19 (as *U. ludwigii*).—**Fig. 593-595.**

On bark of trees in damp woods, rather rare. Europe; Newfoundland to Michigan and south to North Carolina and Tennessee.

EMMET CO.—Cecil Bay. MACKINAC CO.—Mackinac Island, Epoufette, Hendricks Tower.

A curious little moss with pear-shaped capsules abruptly narrowed to a small, puckered mouth. (My impression is that it grows most often on yellow birch trees in beech-maple-hemlock forests and probably near streams.)

2. **Ulota crispa** (Hedw.) Brid.—Plants green, yellow-green, or yellow-brown. Leaves erect and strongly crisped when dry, erect-spreading when moist, 2-3 mm. long, narrowly lanceolate from a broader, concave base, acute or narrowly obtuse; margins entire, plane or sometimes slightly and irregularly revolute along the middle; costa vanishing near the apex; upper cells rounded-quadrate to elliptic, unipapillose on either surface, 8-10 μ. Autoicous. Setae 2-4 mm. long; capsules 1.5-2 mm. long, oblong-cylindric from a long, tapered neck, becoming contracted below the mouth and (rather abruptly) to the neck when dry, strongly 8-ribbed; peristome teeth united in 8 pairs, finely papillose, often perforate near the tips, reflexed when dry; segments 8, well

developed, smooth or rarely very finely papillose. Spores 18-24 $\mu$, spherical, papillose. Calyptrae densely pilose.—n = 10+1, 10+2, 19+1, 19+2, 20+2, 21.

Conard, How to Know the Mosses, (ed. 2) fig. 65c-e. Grout, Mosses with Hand-lens and Microscope, Pl. 38. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 16, (ed. 2) Pl. 20. Welch, Mosses of Indiana, fig. 106.—**Fig. 596-599.**

On bark of trees, usually in moist woods. Europe, North Africa, Canary Islands, Asia; southeastern Alaska; Newfoundland to Wisconsin, south to Tennessee and Georgia.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Fontinalis Run, Livingston Bog, Cheboygan, Grass Bay, Mill Creek, Mud Creek (at Black Lake). EMMET CO.—Pellston, Larks Lake, Cecil Bay, Five Mile Creek, Ramona Beach. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, Gros Cap, Cut River, Epoufette, Ozark, Hendricks. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Clinton Lake.

In small tufts on bark in moist, coniferous forests, contrasting with the *Orthotricha* which occur most commonly on roadside hardwoods. The pale, ribbed capsules with a conspicuous neck and the strongly crisped leaves are the recognizable features of the species.

3. **Ulota hutchinsiae** (Sm.) Hamm.—Small plants in rigid tufts (about 1-1.5 cm. high), dull, yellow-brown to dark-green above, blackish below. Leaves erect and slightly curved but scarcely contorted when dry, erect-spreading when moist, 1.7-2 mm. long, lanceolate, gradually narrowed to a slender, bluntly acute apex; margins ± revolute on 1 or both sides in the lower ½ or sometimes more; costa ending near the apex, upper cells nearly isodiametric, irregularly rounded or elliptic, 8-12 × 7-8 $\mu$, very thick-walled, pellucid, nearly smooth to bluntly and usually obscurely unipapillose on both surfaces. Autoicous. Setae 2.5-3.5 mm. long; capsules about 1.5-2 mm. long, oblong-cylindric (the neck not clearly delimited, usually no more than about ½ as long as the urn), 8-plicate when dry and empty; operculum stoutly long-rostrate from a convex base; exothecial cells differentiated along the ribs; peristome teeth united in 8 pairs (rarely separating with age), erect on dehiscence but generally becoming reflexed, cancellate and often somewhat striolate at the tips, densely papillose below, sometimes with irregular, rather conspicuous, papillose pre-peristome thickenings at the base; segments 8, fairly well developed (1/2-2/3 the length of the teeth), weakly striolate-roughened (or rarely rather distinctly so). Spores spherical, papillose, 9-14 $\mu$. Calyptra copiously hairy.—n = 10, 16.

Conard, How to Know the Mosses, (ed. 2) fig. 65a-b (as *U. americana*). Darlington, Mosses of Michigan, fig. 89. Grout, Moss Flora of North America 2: Pl. 56C (as *U. americana*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 15, (ed. 2) Pl. 19 (as *U. americana*).—**Fig. 600-602.**

Usually (and perhaps always) on acid, siliceous rocks. Europe; Japan; southeastern Alaska; widespread in eastern North America from Newfoundland and Labrador to Minnesota and south to Oklahoma, Arkansas, and Georgia. The only specimen from the Douglas Lake region is one at the New York Botanical Garden presumably collected on granite at Cheboygan by E. Clark in 1941. The record is accepted with reservation, as it is possible, though unlikely, that the species grew there on a glacial erratic. (It has been collected on Sugar Island in Chippewa County.)

This species is named for Ellen Hutchins (1785-1815) of County Cork, Ireland, who collected bryophytes and algae, several of which bear her name. Best recognized by its saxicolous habitat, rigid leaves scarcely contorted when dry, and plicate capsules with a poorly marked neck. Although not likely to be confused with any other *Ulota,* it is superficially similar to *Orthotrichum anomalum,* which grows on calcareous rather than siliceous rocks. From that species, *Ulota hutchinsiae* can be distinguished, as

*Ulota coarctata.* 593. Habit. 594. Leaves. 595. Upper cells at margin of leaf.

*Ulota crispa.* 596. Habit. 597. Leaves. 598. Upper cells at margin of leaf. 599. Cells of alar region.

*Ulota hutchinsiae.* 600. Habit. 601. Leaves. 602. Upper cells at margin of leaf.

*Zygodon virridissimus* var. *rupestris.* 603. Habit. 604. Leaves. 605. Cells at leaf tip. 606. Brood-bodies.

follows: Its capsules are gradually tapered to a longer neck, the peristome teeth reflexed, the stomata superficial, and the cells at the base of the leaves arranged, at least to a degree, in a radiating pattern.

### 3. **Zygodon** Hook. & Tayl.

Rather small plants, scattered or in loose or dense, green, yellowish, brownish, or reddish tufts. Stems erect or ascending, simple or forked, mostly matted with radicles,

usually bearing small, green or brown, ellipsoidal to cylindric brood-bodies on radicles and in leaf axils. Leaves erect and often contorted when dry, spreading to squarrose-recurved when moist, sometimes clearly 5-ranked, mostly oblong to linear-lanceolate and acute or ± acuminate (frequently ending in a pellucid apiculus), rarely lingulate and rounded at the apex; margins mostly plane, rarely recurved below, entire or ± dentate toward the apex (or rarely nearly to the base); costa prominent at back, ending in or below the apex, sometimes excurrent; cells usually uniform nearly to the base, rounded-quadrate or rounded-hexagonal and usually thick-walled, pluripapillose (or less often smooth or unipapillose) on both surfaces, rectangular or rarely linear and usually hyaline near the insertion. Perichaetial leaves scarcely differentiated. Setae terminal, elongate, erect, usually yellowish; capsules erect and symmetric, subcylindric or narrowly pyriform, usually with a fairly long neck, mostly 8-plicate or furrowed; annulus very poorly differentiated, persistent; exothecial cells sometimes differentiated in longitudinal bands; operculum nearly always obliquely long-rostrate from a low, convex-conic base; stomata superficial, in the neck; peristome lacking to rudimentary or well developed and double or single (and then consisting of the endostome), the 16 lanceolate teeth ± joined in pairs at first, papillose, the 8 or 16 segments linear, usually weakly papillose. Spores spherical. Calyptrae cucullate, mostly smooth, naked or rarely hairy, not plicate.—The name signifies yoked or paired teeth, referring to the fact that the 16 teeth of the peristome are at first joined in pairs.

**Zygodon viridissimus** (Dicks.) Brid.—Plants scattered or in small, loose tufts, bright- to dark-green or brownish, not or somewhat tomentose. Brood-bodies 3-6-celled, fusiform, ellipsoidal, and subclavate (with cells sometimes vertically divided). Leaves erect and not or somewhat contorted when dry, erect-spreading or spreading with ± recurved tips when moist, 1-2 mm. long, keeled below, oblong-lanceolate, acute, rather gradually apiculate, ending in a rather long, clear cell; margins plane (but somewhat broadly reflexed when dry), entire, somewhat wavy; costa ending well below the apex; upper cells 7-10 $\mu$, rounded or rounded-hexagonal, thick-walled, rather coarsely pluripapillose on both surfaces; basal cells pale, subquadrate and short-rectangular in a few rows at the insertion. Dioicous. Setae 4-7 mm. long, yellow; capsules 1-1.5 mm. long, narrowly pyriform, furrowed, yellow-brown; operculum slenderly and obliquely long-rostrate; exothecial cells not or slightly differentiated in bands; peristome none or rarely represented by a very low, somewhat papillose membrane. Spores brown, papillose, 11-14 $\mu$. Calyptrae smooth, naked.—n = 12.

Grout, Moss Flora of North America 2: Pl. 58A, 59C.—**Fig. 603-606** (var. *rupestris*).

On bark of trees. New England to North Carolina; Michigan and Ontario; Washington to California; Mexico; Canary Islands; Europe, Caucasus, Asia Minor, and North Africa.

EMMET CO.—Larks Lake. PRESQUE ISLE CO.—Clinton Lake.

A species of little character, most often found scattered and sterile. The acute, gradually apiculate leaves ending in one or more pellucid cells give a hint of its identity. Our material, like most North American collections, belongs to the var. **rupestris** Lindb. *ex* C. J. Hartm., which is characterized by narrower leaves, more gradually narrowed to a longer apiculus of 1-3 pale cells in one row and by brood bodies lacking vertical septations.

Other Orthotrichaceae known from Michigan:

**Drummondia prorepens** (Hedw.) Schimp. Stems elongate and creeping, with numerous erect-ascending branches. Leaves imbricate when dry, not contorted, oblong-lanceolate, blunt or acute, channeled at the costa; cells rounded and green throughout,

smooth. Capsules exserted, smooth; peristome single, consisting of 16 very short, truncate teeth. Spores multicellular, 60-100 $\mu$. Calyptrae cucullate.—On bark of trees. Widespread in eastern North America but not likely to be found in the Straits region.

**Amphidium lapponicum** (Hedw.) Schimp.—Plants in dense cushions. Stems erect, repeatedly forked. Leaves curled and contorted when dry, oblong-lanceolate; upper cells rounded-quadrate, densely warty-papillose; basal cells differentiated, pale. Autoicous; perichaetial leaves pale, sheathing, broad, short-pointed. Capsules half-emergent, urceolate and 8-ribbed when dry and empty; peristome none. Calyptrae cucullate (n = 13, 16).—On cliffs, especially on undersides of projecting ledges. A northerly and montane species likely to be found on the limestone outcrops of Mackinac County, for example.

**Amphidium mougeotii** (BSG) Schimp., of montane distribution farther east, is dioicous, with long, narrow, pointed, and scarcely sheathing perichaetial leaves and capsules just barely exserted. The leaves are moderately flexuose when dry and linear-lanceolate; the upper cells, only moderately opaque, are both papillose and longitudinally striolate, and the basal cells are small and thick-walled.

## CRYPHAEACEAE

Plants rather slender to fairly robust, generally rigid, in loose, dull or somewhat shiny tufts. Primary stems creeping and stoloniform, sparsely radiculose; secondary stems usually ± erect-ascending (rarely pendent or floating), irregularly to subpinnately branched; paraphyllia none or sometimes abundant. Leaves crowded in many rows, mostly imbricate when dry, ± spreading when moist, concave, smooth or sometimes plicate, acute, acuminate, or rarely long-acuminate from an ovate or lanceolate base, unbordered; costa single, ending near the middle to subpercurrent or rarely short-excurrent (rarely short and double in some leaves); cells mostly short, oval to narrowly elliptic, usually thick-walled, smooth or rarely papillose, elongate toward the base and quadrate to rounded- or oblate-quadrate often in many oblique rows at the basal angles. Perichaetia at the ends of very short or sometimes undifferentiated branches; perichaetial leaves often greatly differentiated, elongate, erect and sheathing, with or without a costa, with elongate cells. Setae mostly very short; capsules immersed to ± exserted, erect and symmetric, oblong-ovoid or rarely subglobose or subcylindric, thin-walled, smooth or sometimes ± furrowed when dry; annulus mostly differentiated; operculum conic and acute, rarely nearly flat and apiculate to short-rostrate; peristome inserted below the mouth, mostly double, the teeth narrowly lanceolate or lance-subulate, pale or yellowish, ± papillose; segments from a low basal membrane, narrowly lance-subulate to linear, rarely keeled and perforate, cilia none or sometimes rudimentary. Calyptrae small, conic-mitrate, or rarely split on 1 side and ± cucullate, usually ± rough.

### **Forsstroemia** Lindb.

Slender to moderately robust plants in loose, dull or somewhat shiny, green, yellowish, or brownish tufts. Secondary stems erect, sparsely to freely branched, the branches sometimes curved or subcircinate when dry; paraphyllia none. Leaves loosely erect to imbricate, smooth or somewhat plicate when dry, erect-spreading when moist, ovate-lanceolate to broadly oblong-ovate, gradually or abruptly short- to rather long-acuminate; margins reflexed or ± revolute, entire or serrulate at the apex; costa

single (sometimes weak) and ½-¾ the leaf length, sometimes short and double or lacking in some leaves; cells smooth, thick-walled, rhombic to oblong-fusiform above, rounded-quadrate to oblate-oblong in many rows at the basal margins. Perichaetial leaves long and sheathing, short- to long-acuminate. Setae short (less than 5 mm. long), straight, smooth; capsules immersed to exserted, oblong-ovoid or oblong-cylindric, smooth; annulus narrow and fragmenting or none; operculum conic, acuminate to rostrate; stomata none; peristome teeth narrowly lanceolate, transparent, white to yellowish or reddish, smooth or finely papillose above, sometimes perforate along the middle; endostome lacking to rudimentary. Spores spherical. Calyptrae cucullate, usually ± hairy.—Named for Johan Eric Forsström, a Swedish pastor who traveled in Fennoscandia with Wahlenberg and later sent mosses to Swartz from St. Barthélemy and elsewhere in the West Indes.

**Forsstroemia trichomitria** (Hedw.) Lindb.—Relatively robust plants in soft, whitish-green to pale-yellowish or brownish, slightly shiny tufts. Secondary stems subpinnately branched; branches straight, frequently stoloniform-attenuate at their tips. Leaves erect and somewhat plicate when dry, erect-spreading when moist, 1.2-2 mm. long, concave, oblong-ovate to oblong-lanceolate, acute or short-acuminate; margins entire to slightly serrulate at the apex, reflexed; costa very slender and extending above the leaf middle or shorter and often double or nearly lacking; upper cells oblong-fusiform (about 3.5:1), somewhat shorter at the apex. Autoicous; perichaetial leaves long-sheathing, usually reaching the urn, sometimes surpassing it. Setae 1-3.5 mm. long; capsules immersed to shortly exserted, 1.5-1.8 mm. long, oblong-ovoid; annulus none; operculum stoutly and obliquely rostrate; peristome teeth whitish, becoming yellow with age, faintly roughened or nearly smooth; endostome adhering to the teeth, consisting of a very delicate and irregular, pale membrane with segments sometimes visible as fragments. Spores 21-33 $\mu$, very finely papillose. Calyptrae sparsely pilose.

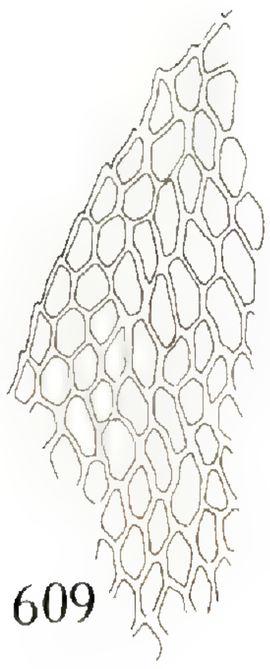
Breen, Mosses of Florida, Pl. 113. Darlington, Mosses of Michigan, fig. 96. Grout, Mosses with Hand-lens and Microscope, Pl. 86. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 32, (ed. 2) Pl. 36 (as *Leptodon*). Welch, Mosses of Indiana, fig. 241 (as *Leptodon*).—**Fig. 607-610.**

On bark of trees (rarely on rock). Eastern Asia; widespread in eastern North America, south to northeastern Mexico. Known from a single collection from our area "Mackinaw" (C. F. Wheeler, 1890, *in herb.* Michigan State University) and included here with reservation, as the Straits area is far north of the expected range of the species.

Somewhat resembling a *Leucodon,* but (among other differences) softer and paler, with secondary stems straight, spreading from the substrate, and subpinnately branched.

## LEUCODONTACEAE

Plants mostly rather robust and rigid in loose mats, with creeping, stoloniform, sparsely radiculose or rarely tomentose primary stems and numerous, erect, curved-ascending, or rarely pendent, simple or branched secondary stems without radicles; paraphyllia none. Leaves crowded in many rows, ovate or ovate-lanceolate, ± acuminate, somewhat decurrent, often concave, unbordered; costa single, double, or sometimes lacking; cells thick-walled, mostly smooth, rarely unipapillose on 1 or both surfaces, oval or rhombic to linear-rhomboidal above, elongate below, with subquadrate and often oblate-oblong cells in many oblique rows at the basal margins. Dioicous; paraphyses filiform, few; perichaetia terminating short branches; inner perichaetial leaves elongate and sheathing. Setae very short to elongate; capsules immersed to



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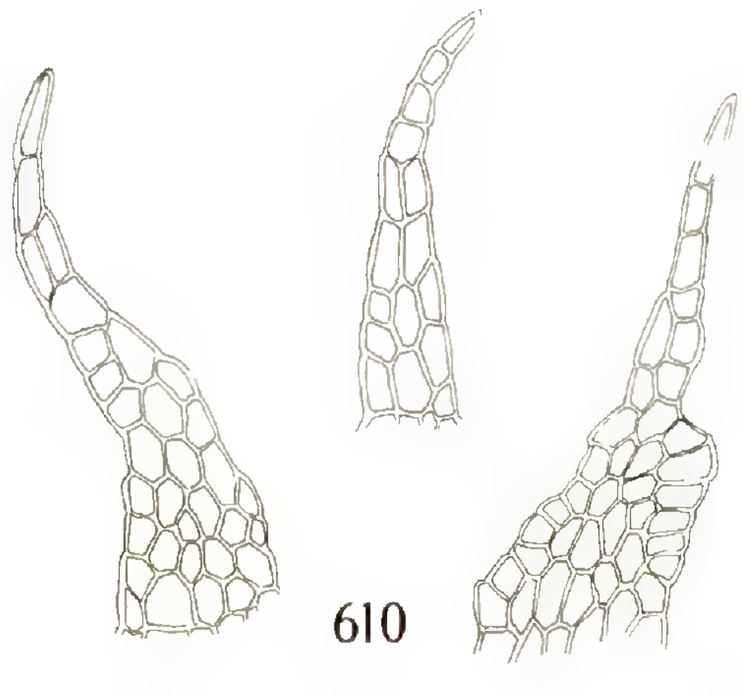

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*Forsstroemia trichomitria*. 607. Habit. 608. Leaves. 609. Upper cells of leaf. 610. Pseudoparaphyllia.

exserted, mostly erect, symmetric, subglobose to ovoid or subcylindric; annulus mostly differentiated; operculum conic or obliquely rostrate from a conic base; stomata mostly lacking; peristome double or the endostome sometimes rudimentary or apparently lacking, the 16 teeth lanceolate or lance-subulate, mostly papillose, rarely ± cross-striolate, unbordered; basal membrane low, segments lacking or rudimentary, or rarely well developed, narrow and sometimes as long as the teeth, cilia none. Calyptrae cucullate, naked or sparsely hairy.

## **Leucodon** Schwaegr.

Coarse and often robust plants in dull, dark-green or yellow-brown, rigid tufts. Secondary stems simple or sparsely branched, usually terete, often stoloniform-attenuate. Leaves erect or appressed to subsecund when dry, erect- to wide-spreading when moist, ovate or ovate-lanceolate, acute or acuminate, mostly plicate; margins plane to reflexed or revolute, entire or serrulate at the apex; costa lacking; cells smooth, thick-walled, shortly oblong-rhomboidal above, becoming longer below, yellow at the insertion, rounded-quadrate and transversely oblong in many rows at the margins in the lower half or more. Perichaetial leaves very long-sheathing, acuminate, with all cells elongate. Setae very short to elongate, smooth; capsules mostly exserted, erect and symmetric, oblong-cylindric or ellipsoidal, narrow at the mouth, smooth; annulus none; operculum conic or obliquely rostrate; stomata none; peristome teeth inserted below the mouth, whitish, becoming yellowish with age, narrowly lanceolate, mostly perforate, papillose; endostome rudimentary, sometimes apparently lacking. Spores spherical. Calyptrae often split on 1 side nearly to the base which envelopes the tip of the seta until the capsule is mature, smooth (or frequently plicate at base), naked.—Named for the pale or whitish teeth of the peristome.

Slender, flexuose branchlets regularly produced in clusters in the axils of some leaves; leaves ovate-lanceolate, gradually acuminate, plicate — 2. *L. brachypus* var. *andrewsianus*

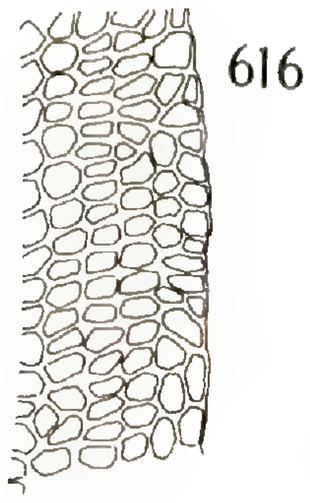
Slender branchlets not produced in leaf axils; leaves broadly oblong-ovate, rather abruptly short-acuminate, not or obscurely plicate — 1. *L. julaceus*

1. **Leucodon julaceus** (Hedw.) Sull.—Plants rather small to moderately robust, dark-green to yellow-brown. Secondary stems short, simple or forked, julaceous and straight or curved when dry, frequently stoloniform-attenuate; brood-branchlets absent. Leaves particularly crowded, erect or appressed when dry, wide-spreading when moist, not at all secund, 1-1.3 mm. long, broadly oblong-ovate, rather abruptly short-acuminate, concave, not or only obscurely plicate when dry; margins plane or somewhat reflexed, serrulate at the extreme apex; upper cells linear-fusiform, those at the apex with somewhat bulging walls at the back. Dioicous; perichaetial leaves usually ending well below the urn, sometimes as long as the seta or slightly longer. Setae 2.5-8 mm. long, straight or somewhat curved, dark-red; capsules shortly exserted, 1.1-1.5 mm. long, oblong-ellipsoidal, brown or yellow-brown, red at the mouth, ± constricted below the mouth when dry; operculum obliquely rostrate; peristome teeth finely perforate; endostome a low, pale, papillose membrane. Spores 33-47 $\mu$, varying in size in the same capsule, densely and finely papillose. Calyptrae tardily deciduous, split nearly to the base on 1 side and clasping the seta below the urn.—n = 10.

Breen, Mosses of Florida, Pl. 111. Grout, Mosses with Hand-lens and Microscope, fig. 212a, j, 213d-f. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 32, (ed. 2) Pl. 36. Welch, Mosses of Indiana, fig. 240.—**Fig. 611-612.**

Typically on the trunks of trees (but sometimes on the bases or on exposed roots), occasionally on decayed logs and stumps or rocks. Widespread in eastern North America; northern Mexico. Known from a single local collection, from the Gorge of Carp Creek, Cheboygan Co. ( *C. B. Arzeni*). The origin of the specimen may be questioned, inasmuch as the normal range of the species is far southward.

The plants are smaller than those of *L. brachypus* var. *andrewsianus* and differ also in the absence of axillary branchlets and in abruptly short-acuminate leaves with upper cells somewhat bulging at back.



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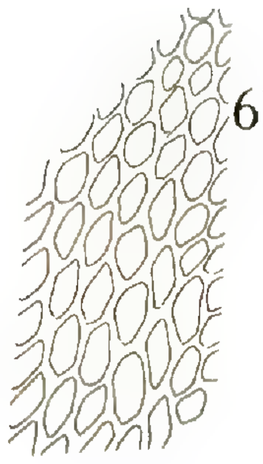

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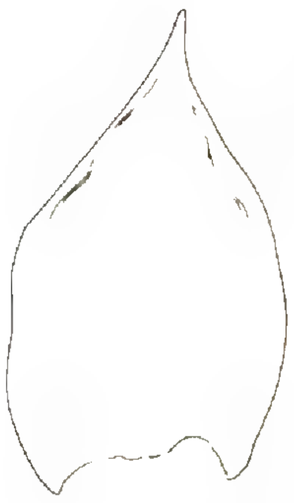

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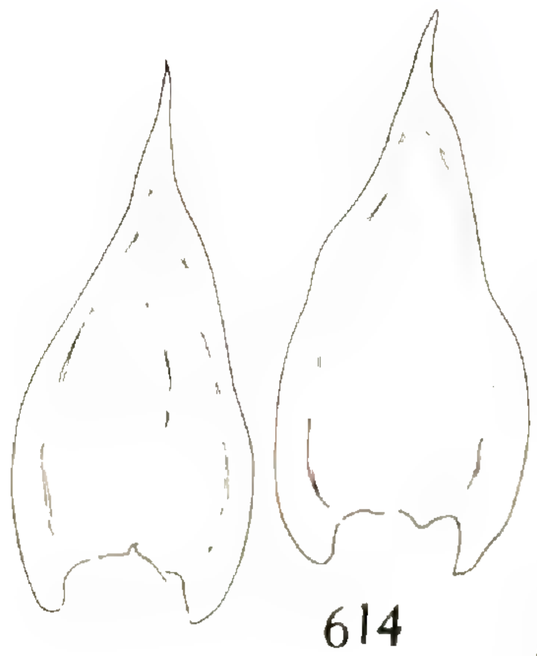


614

*Leucodon julaceus.* 611. Leaves. 612. Upper cells of leaf.
*Leucodon brachypus* var. *andrewsianus.* 613. Habit. 614. Leaves. 615. Upper cells. 616. Basal calls at margin.

2. **Leucodon brachypus** Brid. var. **andrewsianus** Crum & Anders. (*L. sciuroides sensu* Amer. authors)–Plants variable in size but usually moderately coarse and robust, dull, dirty-green to brownish. Secondary stems terete and usually curved when dry; stoloniform branches often present; brood-branchlets few to numerous in leaf axils. Leaves crowded, appressed, and sometimes slightly secund when dry, erect-spreading when moist, plicate wet or dry, 1.4-2.2 mm. long, ovate-lanceolate, acuminate, subentire or slightly serrulate at the extreme apex; upper cells narrowly oblong-linear, ± flexuose, thick-walled and somewhat pitted, without irregularly thickened walls bulging at the back of the leaf tip. Inflorescences and sporophytes unknown.–n = 11.

Grout, Mosses with Hand-lens and Microscope, fig. 212b, g-i (as *L. sciuroides*).–**Fig. 613-616.**

On the bark of trees in open woods (locally in both hardwood and coniferous swamps), rarely also on limestone rocks. Widespread in eastern North America from Nova Scotia through the Great Lakes and south to North Carolina.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Smiths Bog, Livingston Bog, Colonial Point, Riggsville, Mud Lake, Mill Creek, Mud Creek (at Black Lake). EMMET CO.–Levering, Larks Lake, Maple River, Middle Village, Five Mile Creek. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, Gros Cap, Peggley Lake, Caffey Corner, Hendricks, Ozark. PRESQUE ISLE CO.–Rainy River Falls, Rainy Lake.

The clusters of branchlets in the leaf axils can always be found somewhere in a collection of this common moss so long referred to *L. sciuroides* (Hedw.) Schwaegr., an Old World species with similar branchlets but otherwise quite unlike the American plants. The branches curve upward when dry in the manner of a *Pylaisiella.*

## FONTINALACEAE

Plants elongate, slender to robust, aquatic or submerged at least at high water, mostly dull and dark, irregularly to subpinnately branched, prostrate and trailing from a single point of attachment, radiculose only at base and usually denuded of leaves and branches for some distance above the base. Leaves in 3 rows and sometimes clearly ranked, erect, erect-spreading, or sometimes falcate-secund, little changed on drying, broadly ovate to narrowly lanceolate and blunt or acute to acuminate or long-subulate, keeled or concave and often cucullate at the apex or nearly flat, entire or ± toothed at the apex, often ± decurrent, sometimes auriculate; costa lacking or single and percurrent to long-excurrent; upper cells oblong-hexagonal to linear, smooth; lower cells shorter, broader and often pitted and colored, the alar cells sometimes clearly differentiated. Perichaetia at the end of short branches; perichaetial leaves greatly differentiated, sheathing. Setae very short to elongate, straight; capsules immersed to exserted, erect and symmetric, ovoid to cylindric, smooth; annulus and stomata none; operculum bluntly conic to rostrate; peristome double, the teeth sometimes shorter than the endostome, 16, narrowly lance-acuminate, entire or perforate to gaping along the middle, sometimes united in pairs at the tips, mostly coarsely papillose; endostome without a basal membrane, the segments filiform, mostly united at least above by lateral projections to form a keeled, latticed cone open at the apex, rarely free and nodose to appendiculate. Calyptrae conic-mitrate or cucullate.

Leaves long and slender, acuminate to setaceous, ± falcate-secund, keeled, costate; alar cells scarcely differentiated ..... 2. *Dichelyma*
Leaves broader, blunt or acute, not secund, flat, concave or keeled, ecostate; alar cells somewhat differentiated ..... 1. *Fontinalis*

### 1. **Fontinalis** Hedw.

Plants submerged and trailing, freely and usually irregularly branched above a denuded base, slender and filiform to robust, variously colored, usually dull and dark. Stem and branch leaves similar (except sometimes in size), in 3 rows (sometimes obviously ranked), erect or erect-spreading, not much altered on drying, broadly ovate to lanceolate, acute or sometimes blunt at the apex, sometimes ± toothed at the tip, keeled, concave, or nearly flat, sometimes decurrent and often ± auriculate; costa lacking; cells oblong- to linear-rhomboidal, smooth; alar cells ± differentiated. Mostly dioicous; perichaetial leaves large, broadly oblong-ovate, blunt or rounded at apex or sometimes broadly short-pointed. Setae very short; capsules immersed to emergent; operculum conic; peristome double, the 16 teeth about as long as the endostome, narrowly lanceolate, flat, often joined in pairs at the apex, sometimes perforate or cleft along the median line, red, smooth or papillose, the segments filiform and usually joined (at least above) by lateral appendages into a ± plicate, latticed cone open at the top, rarely free and appendiculate. Spores spherical. Calyptrae mitrate, long-rostrate, scarcely reaching below the operculum, smooth, naked.—The name refers to springs or "fountains." (Our local stream, Fontinalis Run, is named not for the moss but for the Brook Trout, *Salvelinus fontinalis.*) Surely the most difficult genus of mosses, *Fontinalis*, sometimes called WATER MOSS or BROOK MOSS, is usually found in running water. The leaves are sometimes keeled and arranged in three distinct rows. In

a pre-Linnaean publication (but not the famous *Historia Muscorum*), Dillenius gave one of these, now known as *F. antipyretica* Hedw., the name *Selago aquatica* because of a resemblance to our modern concept of *Lycopodium.* I have seen *F. antipyretica* fo. *robusta* (Card.) Card. (*F. gigantea* Sull. *ex* Sull. & Lesq.) in dry, stranded masses with dark-green, rigid, keeled leaves in obvious rows and looking much like a clump of the Crow Berry, *Empetrum nigrum*, in dry arctic tundra. We have none of the species with keeled and ranked leaves locally. The most common of them, *F. antipyretica*, was so-named by Linnaeus because of use by Swedish peasants in caulking between the chimney and the walls of houses in a vain hope of preventing fires.

It is commonly assumed that bryophytes are simple plants, evolved from aquatic green algae and barely eking out an existence on land. Some of them may be derived directly from the algae, but the division Bryophyta is no doubt polyphyletic in origin, and the Musci at least seem to be derived by reduction from primitive vascular plants already adapted to terrestrial living and the aquatic species secondarily derived from terrestrial origins.

Aquatic mosses are actually few and exceptional and they are highly evolved along widely divergent phylogenetic lines. All of them are related to species or genera obviously well adapted to life on land. The well-developed peristomes of *Fontinalis* and most other truly aquatic mosses, together with the vestigial stomata prevalent throughout the class, give evidence of reduction from a terrestrial stock. The vascular tissue of *Polytrichum* gametophytes, obviously xylem and phloem in form, arrangement, and function, indicates a genetic potential, possessed but not used by the diploid sporophyte. I believe the mosses and the most primitive pteridophytes were derived from the same source, from a terrestrial plant with vascular tissue, swimming sperms, well-defined gametophytes, attached, unbranched sporophytes, no roots or leaves, and homospory.

Leaves somewhat concave, narrowly lanceolate and narrowly acuminate ..... 1. *F. disticha*
Leaves nearly flat, ovate and broadly pointed to ovate-lanceolate and narrowly acuminate ..... 2. *F. hypnoides*

1. **Fontinalis disticha** Hook. & Wils. *ex* Drumm.—Slender plants about 15 cm. long, in rather shiny, yellowish or brownish masses. Stem leaves loosely erect or erect-spreading, slightly concave, 4-5 mm. long, narrowly lanceolate, gradually long-acuminate, acute, slightly decurrent; cells linear-rhomboidal. Branch leaves similar, loosely erect, imbricate at branch tips. Dioicous. Setae virtually lacking; capsules immersed or slightly emergent, cylindric or oblong-cylindric, 1.7-3 mm. long; operculum large, high-conic, acute; peristome inserted somewhat below the mouth, granulose, the teeth not or only occasionally perforate at base, the segments strongly appendiculate throughout but joined in a trellis only above. Spores 13-22 $\mu$, finely papillose.

Breen, Mosses of Florida, Pl. 118 (fig. 1-4). Grout, Moss Flora of North America 3: Pl. 75 (figs. 10-14). Welch, Mosses of Indiana, fig. 246.

Attached to rocks or bases and roots of trees and shrubs and submerged in pools or streams (probably in stagnant or sluggish water), eastern United States.

CHEBOYGAN CO.—Pigeon River.

2. **Fontinalis hypnoides** C. J. Hartm.—Rather slender to medium-sized plants in loose, soft, usually somewhat shiny, yellow-brown, or (less often) bright- to sordid-green, irregularly branched masses. Stem leaves usually remote, loosely erect or erect-spreading, slightly concave or nearly flat, somewhat clasping at the insertion,

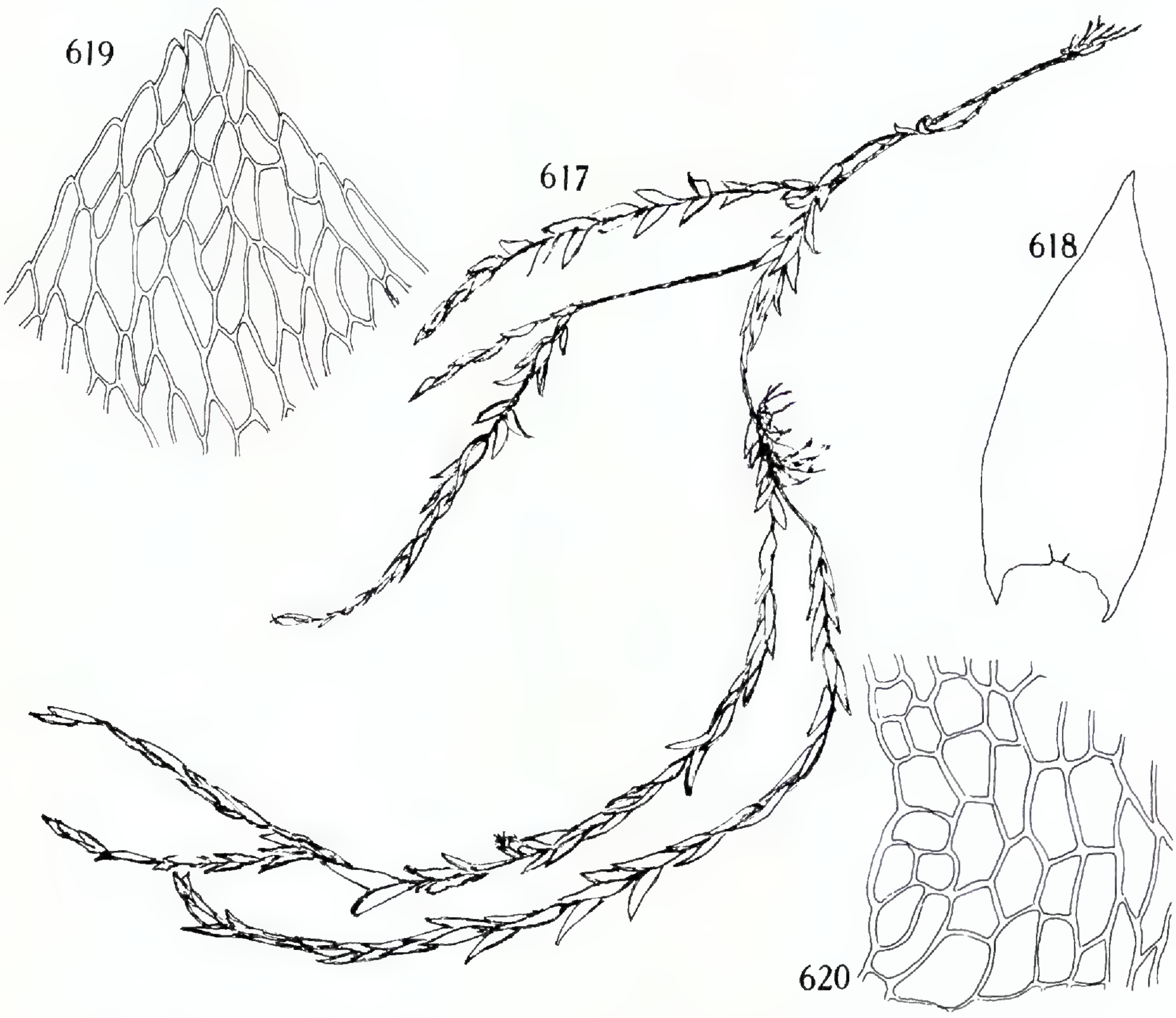
3-4.5 mm. long, ovate and rather broadly acuminate or ovate-lanceolate and longer-pointed, acute, entire or ± serrulate at the apex, decurrent; cells long-rhomboidal or linear-rhomboidal; alar cells somewhat enlarged, short-oblong, sometimes brownish. Branch leaves similar, 2-3, sometimes 4 mm. long. Dioicous; perichaetial leaves broadly rounded at apex. Setae about 0.25 mm. long; capsules immersed, about 1.5-2 mm. long; operculum large, bluntly conic; peristome granulose (the teeth sometimes ± perforate at base), the endostome latticed throughout. [Spores 14-20 $\mu$, smooth or finely papillose, according to Welch.]

Conard, How to Know the Mosses, (ed. 2) fig. 253a-d (as *F. duriaei*). Grout, Moss Flora of North America 3: Pl. 77 (as *F. nitida, F. tenella, F. duriaei,* & *F. hypnoides*). Welch, Mosses of Indiana, fig. 250 (as *F. duriaei*).–**Fig. 617-620** (as var. *duriaei*).

Attached to roots, logs, twigs, or rocks and submerged in shallow, flowing water, less commonly at the margins of lakes. Europe, Asia, Africa, Brazil; widespread in North America, from Alaska to Nova Scotia and south to California, Arizona, Texas, Missouri, and Pennsylvania.

CHEBOYGAN CO.–Beavertail Creek, Bessey Creek, Gorge of Carp Creek, Iron Bridge, E. branch of Maple River, Lancaster Lake, Fontinalis Run, Nigger Creek, Mill Creek, 3 miles north of Cheboygan, "limestone creek" south of Mackinaw City, Duncan Bay, Myers Creek and Mud Creek (at Black Lake). EMMET CO.–Maple River, Arnott Lake, between Levering and Carp Lake, Carp Lake. MACKINAC CO.–Prentiss Bay. PRESQUE ISLE CO.–Rainy River Falls.

Our material can be referred with no hesitation to *F. duriaei* Schimp., but I see no way of sorting it from the variability of *F. hypnoides,* the differences being at best




*Frontinalis hypnoides* var. *duriaei.* 617. Habit. 618. Leaf. 619. Upper cells of leaf. 620. Alar cells.

rather insignificant. Larger, laxer, softer forms can be referred to var. **duriaei** (Schimp.) Husn., especially small forms to var. **hypnoides.**

Because surface waters rapidly percolate into our loose sands or into the porous limey bedrock, we have few permanent brooks and therefore only a poor showing of *Fontinalis.* We have at least eight species in the state: *F. antipyretica* Hedw., *F. disticha* Hook. & Wils. *ex* Drumm., *F. dalecarlica* BSG, *F. hypnoides* var. *duriaei, F. neo-mexicana* Sull. & Lesq., *F. novae-angliae* Sull., *F. patula* Card., and *F. sphagnifolia* (C. M.) Wijk & Marg. Records of two southern species, *F. filiformis* Sull. & Lesq. *ex* Aust. and *F. flaccida* Ren & Card., should be viewed as phytogeographically improbable. It is also unlikely that the western *F. neo-mexicana* actually came from Manistee County, although the specimen is correctly named and the collector, E. J. Hill, did indeed gather plants in the county.

The following key may aid in identification of species collected elsewhere in Michigan. For further aid in identification, see Welch's monograph in Grout's *Moss Flora of North America* (vol. 3) or her world-wide *Monograph of the Fontinalaceae.*

1. Leaves keeled, obviously 3-ranked
 2. Keel straight — *F. patula*
 2. Keel curved
  3. Leaves oblong-lanceolate, acute; cells linear; perichaetial leaves narrow, abruptly apiculate — *F. neo-mexicana*
  3. Leaves ovate-lanceolate or broader, obtuse; cells linear-rhomboidal; perichaetial leaves very broad, obtuse — *F. antipyretica*
1. Leaves not keeled or ranked
 4. Leaves essentially flat — *F. hypnoides* var. *duriaei*
 4. Leaves ± concave
  5. Branch tips terete because of appressed leaves
   6. Margins of leaves reflexed when dry; leaves ± erect; branches conspicuously terete; perichaetial leaves broadly acute or apiculate — *F. dalecarlica*
   6. Margins not reflexed when dry; leaves generally looser, more spreading except at branch tips which are less obviously terete; perichaetial leaves obtuse or rounded — *F. novae-angliae*
  5. Branch tips not particularly terete; leaves loosely erect-spreading
   7. Leaf margins broadly involute above, sometimes nearly throughout — *F. sphagnifolia* (summer form)
   7. Leaf margins not involute
    8. Leaves narrowly lanceolate, acuminate; upper cells linear-rhomboidal — *F. disticha*
    8. Leaves broader, lanceolate to ovate-lanceolate, obtuse; upper cells shorter, rhomboidal — *F. sphagnifolia* (spring form)

## 2. **Dichelyma** Myr.

Plants rather slender but elongate, in loose, rather glossy, yellow-brown, golden-brown, or sordid-green mats submerged at high water. Stems prostrate and trailing, irregularly branched. Stem and branch leaves similar, in 3 ranks, mostly secund and sometimes falcate or circinate, keeled and ± conduplicate, lanceolate to linear-lanceolate, gradually acuminate and sometimes filiform-subulate, not or slightly decurrent; margins serrulate toward the apex; costa subpercurrent to long-excurrent; cells long, linear-rhomboidal, smooth, only slightly differentiated at the basal angles. Dioicous; perichaetial leaves long, oblong, acuminate, convolute and ± twisted, ecostate, entire. Setae short to elongate, straight; capsules immersed (and sometimes emerging from the side of the perichaetium) to exserted, erect and symmetric, oblong-cylindric, brown or yellow-brown; operculum conic, acute to obliquely rostrate; exothecial cells hexagonal; peristome teeth inserted somewhat below the mouth, shorter than the endostome, narrowly lanceolate, perforate along the middle, brown, papillose, with pre-peristome thickenings at base; endostome consisting of long, flat,

linear segments joined by lateral appendages only at the apex or throughout to form a trellis-like cone, brown, papillose. Spores spherical. Calyptrae long, cucullate, covering the capsule and clasping the tip of the seta until maturity.—This genus was named in reference to a cleft veil, or calyptra.

Leaves lanceolate, acute or obtuse, rather clearly 3-ranked, strongly keeled and conduplicate; costa subpercurrent ..... 2. *D. pallescens*
Leaves linear-lanceolate, filiform-acuminate, only obscurely 3-ranked, keeled but not obviously conduplicate; costa long-excurrent ..... 1. *D. capillaceum*

1. **Dichelyma capillaceum** (With.) Myr.—Plants of moderate size, in yellow-brown or dark-green, not or somewhat shiny masses. Leaves loosely erect and usually ± secund, indistinctly 3-ranked, keeled but not noticeably conduplicate, 3-7 mm. long, linear-lanceolate, filiform-acuminate; costa long-excurrent. Perichaetial leaves up to 7.5 mm. long. Setae 2-4 mm. long; capsules 1.5-2.2 mm. long, immersed but becoming laterally emergent, oblong-cylindric; operculum obliquely long-rostrate; exostome teeth orange-brown, densely spiculose-papillose; endostome similarly orange-brown and spiculose-papillose, with long, perforate segments joined only at the tips in a small trellis. Spores 13-17 $\mu$, very minutely papillose to nearly smooth.

Breen, Mosses of Florida, Pl. 119 (fig. 5-7). Conard, How to Know the Mosses, (ed. 2) fig. 200. Grout, Mosses with Hand-lens and Microscope, fig. 219, Moss Flora of North America 3: Pl. 79 (figs. 38-42). Welch, Mosses of Indiana, fig. 251.—**Fig. 621.**

On roots or bases of trees, shrubs, or stumps, sometimes on fallen twigs, branches, or rocks, in swamps, submerged at high water. Europe; eastern North America.

CHEBOYGAN CO.—Carp Creek.

The leaves are long-setaceous and not obviously ranked or strongly keeled. The plants can be taken, in carelessness, for a *Dicranum* or a *Drepanocladus*!

2. **Dichelyma pallescens** BSG—Plants relatively robust, yellow-brown or green, somewhat shiny. Leaves rather clearly 3-ranked, falcate-secund, strongly keeled and conduplicate, 3-4 mm. long, lanceolate and rather broadly acuminate, acute or obtuse; costa subpercurrent or ending somewhat below the apex. Perichaetial leaves up to 7.5 mm. long. Setae 3-5 mm. long; capsules immersed but becoming laterally emergent, 1.2-2 mm. long, oblong-cylindric; operculum obliquely rostrate; exostome teeth brown, finely papillose; endostome segments darker-brown, finely papillose, perforate, joined only at the tips as a small trellis. Spores 11-15 $\mu$, minutely roughened or nearly smooth.

Grout, Mosses with Hand-lens and Microscope, fig. 220, Moss Flora of North America 3: Pl. 79 (figs. 43-47). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 31, (ed. 2) Pl. 35.—**Fig. 622-624.**

On roots and bases of trees or sticks and stones in swampy woods, submerged at high water. Northeastern United States and adjacent parts of Canada.

CHEBOYGAN CO.—Colonial Point, Black Lake.

As compared with *D. capillaceum,* the leaves are paler, somewhat glossy, clearly 3-ranked, strongly keeled, and not as slenderly pointed.

**Dichelyma falcatum** (Hedw.) Myr. occurs elsewhere in the state. Like *D. pallescens* it has lanceolate leaves which are strongly keeled-conduplicate and clearly

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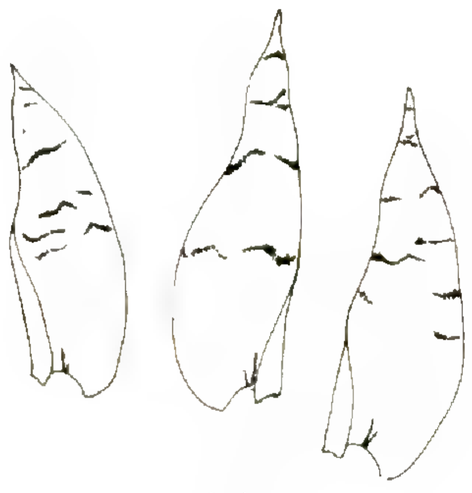


626

*Dichelyma capillaceum.* 621. Leaf.
*Dichelyma pallescens.* 622. Habit. 623. Leaf. 624. Upper cells.
*Neckera pennata.* 625. Habit. 626. Leaves. 627. Upper cells of leaf.

3-ranked. But the leaves are slenderly acute or even setaceous-pointed with a percurrent to excurrent costa, and the endostome segments are joined throughout their lengths to form a conspicuous conical trellis.

## NECKERACEAE

Mostly rather robust, attractive plants in loose, often glossy tufts, with filiform, creeping primary stems and erect to pendent, simple to pinnate secondary stems, usually without paraphyllia. Leaves crowded, mostly complanate, often undulate, of many forms, mostly oblong-ovate or elliptic, sometimes cordate, acute to rounded or

truncate at apex, frequently ± asymmetric; costa mostly single, sometimes weak and ending well below the apex, rarely double or lacking; cells mostly smooth, rounded-quadrate, rhombic, or rhomboidal above, elongate or linear below. Perichaetia lateral; perichaetial leaves differentiated. Setae very short to elongate; capsules immersed or sometimes exserted, mostly erect, ovoid to cylindric; annulus mostly undifferentiated; operculum conic, mostly rostrate, often obliquely so; stomata present or lacking; peristome double, the teeth 16, lanceolate, sometimes with a pre-peristome; basal membrane ± well-developed, segments linear, sometimes variously perforate or cleft, occasionally rudimentary, cilia usually none. Calyptrae mitrate or cucullate, often hairy.

Leaves oblong-ovate or ovate-lanceolate, acute or acuminate, undulate wet or dry; capsules immersed ..... 1. *Neckera*
Leaves broadly oblong-lingulate, rounded at apex or occasionally rounded-obtuse and apiculate, smooth; capsules exserted ..... 2. *Homalia*

## 1. **Neckera** Hedw.

Plants medium-sized or ± robust, in loose, green, brownish-green, or yellowish, somewhat glossy mats, often stoloniferous. Secondary stems erect or spreading to horizontal, simple to pinnate or bipinnate; branches blunt or attenuate; paraphyllia usually lacking. Leaves inserted in 8 rows but spreading and complanate, asymmetric, oblong-lingulate to oblong-ovate, acute to acuminate or rounded to truncate or emarginate, sometimes blunt and apiculate, mostly undulate, shortly decurrent; margins entire or serrulate, inflexed on 1 side below; costa single and extending ½-¾ the leaf length or short and double or lacking; cells smooth, mostly ± pitted, rhombic to rhomboidal at the apex, mostly oblong-linear below, ± differentiated at the basal angles (small and quadrate). Perichaetial leaves long-sheathing, rather narrowly acuminate. Setae short or elongate; capsules immersed to long-exserted, ellipsoidal to oblong-cylindric, erect and symmetric; operculum obliquely rostrate from a conic base; peristome teeth narrowly lanceolate, smooth or papillose, sometimes variously striolate below; basal membrane of endostome rather low (and sometimes lacking); segments linear, sometimes slit along the keel, sometimes short and fugacious, cilia none. Spores spherical. Calyptrae cucullate or rarely mitrate, sometimes hairy.—Named for Noel Martin Joseph de Necker (1730-1793), a French-born botanist of Mannheim who studied both sexual and asexual reproduction in bryophytes.

**Neckera pennata** Hedw.—Plants medium-sized to fairly large, in soft, shiny, light-green to yellow-green mats. Secondary stems horizontal or somewhat pendent, subpinnately branched; attenuate branches few or none; paraphyllia none. Leaves undulate, 2-2.5 mm. long, oblong-lanceolate to oblong-ovate, acute or acuminate; margins serrulate at the apex and indistinctly sinuose-serrulate to the middle or below; costa short and double or lacking; upper cells oblong-linear, flexuose ± thick-walled, somewhat shorter and oblong-rhombic at the apex, subquadrate and shortly rectangular in small alar groups. Autoicous; perichaetial leaves usually considerably longer than the capsules, rarely slightly exceeding the mouth. Setae shorter than the capsules (about 1 mm. long or less); capsules immersed, about 1.5 mm. long, oblong-ovoid, brown; annulus and stomata none; operculum obliquely apiculate to short-rostrate from a conic base; peristome teeth inserted below the mouth, pale, sometimes irregularly perforate and often cohering at the tips, obscurely cross-striolate at base, smooth or nearly so above; endostome consisting of short, delicate, irregular, linear segments mostly adhering to the teeth, the basal membrane apparently lacking. Spores 18-32 $\mu$, densely papillose. Calyptrae small (covering the operculum), cucullate, smooth, naked.—n = 10.

Conard, How to Know the Mosses, (ed. 2) fig. 300. Darlington, Mosses of Michigan, fig. 98. Grout, Mosses with Hand-lens and Microscope, fig. 215, 216 (as var. *oligocarpa*). Welch, Mosses of Indiana, fig. 238.–**Fig. 625-627.**

Typically on the trunks of trees in moist, coniferous woods, occasionally on logs or rocks. Europe, Asia, Africa, Australia, and New Zealand; Alaska to Labrador, south to Arizona, New Mexico, the Great Lakes, and Tennessee.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Grass Bay. EMMET CO.–Levering, Pleasantview Swamp, Larks Lake, Cross Village, Good Hart, Cecil Bay, Five Mile Creek, Harbor Springs, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Prentiss Bay, Gros Cap, Cut River, Epoufette, McNamara Pond. PRESQUE ISLE CO.–Presque Isle Lighthouse, Lamprey Experiment Station, Clinton Lake.

Although the plants become faded and shaggy, they can be remarkably beautiful, recognizable at a glance by the flat branches spreading outward from trunks of trees, with soft, shiny, complanate, wavy leaves and an abundance of immersed capsules.

## 2. **Homalia** (Brid.) BSG

Plants slender or moderately robust in strongly flattened, green, or yellow, shiny mats. Stems creeping, simple to irregularly or subpinnately branched, often stoloniferous; paraphyllia none. Leaves in 8 rows, strongly complanate and appearing distichous, smooth, oblong-cultiform to nearly circular, blunt or rounded-obtuse to rounded, shortly decurrent; margins entire or somewhat serrulate (or rarely coarsely toothed) at apex, inflexed on 1 or both sides at base; costa single, extending to or beyond the leaf middle, or rarely lacking or very short and double; cells smooth, small and rounded-hexagonal to rhombic or rarely linear above, becoming ± elongate and usually linear below. Perichaetial leaves short-sheathing, lance-acuminate. Setae elongate; capsules mostly erect, sometimes inclined and ± curved with age, rarely pendulous, oblong or subcylindric from a narrow base, red-brown, smooth; annulus well developed; operculum obliquely rostrate from a conic base; peristome teeth lance-subulate, yellow or brownish and cross-striolate below, hyaline and papillose at the tips, with well-developed trabeculae; endostome pale-yellowish, smooth or finely papillose, the basal membrane high, the segments linear-lanceolate, keeled, perforate, cilia none, rudimentary and fugacious, or rarely well-developed and appendiculate. Spores spherical. Calyptrae cucullate, mostly naked.–The name refers to the flattened stems and branches owing to strongly complanate leaves.

**Homalia trichomanoides** (Hedw.) BSG–Plants in shiny, green or yellowish, very flat mats. Stems freely and irregularly branched (rarely producing terete-foliate, stoloniform branches with small, pointed leaves). Stem and branch leaves similar, wide-spreading and very strongly complanate, smooth or faintly striolate and often decurved at the tips when dry, 1-2 mm. long, asymmetric, oblong-lingulate, rounded at the apex or less often obtusely pointed to apiculate; margins inflexed on 1 side at base, irregularly serrulate in the upper 1/3 or more, faintly serrulate nearly to the base on the convex side; costa slender, usually single and extending ½-¾ the leaf length, occasionally short and double; cells firm-walled, rhombic (1-1.5:1) near the apex, gradually becoming oblong-linear below, porose near the insertion. Autoicous. Setae 9-11 mm. long, red, smooth; capsules 1.5-2 mm. long, suberect and slightly asymmetric, narrowly oblong-cylindric, tapered at the neck; annulus large, fragmenting; operculum long-rostrate; stomata few, in the neck; peristome teeth yellowish, bordered below; endostome pale and smooth, as long as the teeth, with cilia none or occasionally single and delicate. Spores 14-16 $\mu$, very finely papillose. Calyptrae smooth and naked.–n = 11, 11+1.

Conard, How to Know the Mosses, (ed. 2) fig. 223 (as *H. jamesii*). Darlington, Mosses of Michigan, fig. 99. Grout, Mosses with Hand-lens and Microscope, fig. 214.–**Fig. 628-630.**

A calciphile, on cliffs and boulders (especially at their bases), less commonly on bark at base of trees. Circumpolar; British Columbia to Oregon; Arizona; Mexico; Newfoundland to Wisconson, south to Tennessee and Arkansas.

CHEBOYGAN CO.–Grapevine Point (Douglas Lake), Carp Creek. EMMET CO.–Levering, Larks Lake, Wilderness State Park. MACKINAC CO.–Ozark, Caffey Corner.

A pretty, flat, shiny moss somewhat resembling a leafy liverwort. Many pleurocarpous mosses, like this one, are complanate-foliate (and often conspicuously flattened), but the leaves are actually inserted in many rows. In a few genera of acrocarps, such as *Fissidens, Bryoxiphium, Distichium,* and *Schistostega,* the leaves result from the activities of a 2-sided apical cell and are indeed in two rows. Such plants have a 1/2 phyllotaxy, *i.e.,* only two leaves arise from the circumference of the stem and are thus spaced at 180°. This arrangement is repeated in a spiral in which every other leaf is aligned in the same row. When leaves of each cycle are more numerous, the spiral arrangement is more obvious, at times conspicuous. Since the apical cell is normally 3-sided, it might be expected that the leaves would be in three vertical rows, but in most mosses the segments of the apical cell are asymmetric, the right-hand side being much thicker then the left, so that as growth proceeds the apical cell gradually turns counter-clockwise, in some genera more strongly than in others. This torsion growth tends to shift leaves spirally and distort the original 1/3 arrangement. Kerner von Marilaun (*The Natural History of Plants,* pp. 396-407. 1904) pointed out that the position of leaves is usually related to their shape. If the leaves are obovate and short-stalked, as in most oaks, they are arranged in five rows in a 2/5 phyllotaxy. If they are lanceolate or oval, as in almond or peach trees, they usually have a 3/8 phyllotaxy. The long, narrow leaves of many willows have a 5/13 phyllotaxy. Similarly, in mosses, the narrower the leaves the more numerous the rows. The broad leaves of Mniums display a 1/3 arrangement; the linear leaves of Polytrichums have 3/8, 5/13, or even more complex phyllotaxies. It is my impression that the 2/5 phyllotaxy is the most common among mosses. In this arrangement, the leaves are inserted at distances equal to 2/5 the circumference of the stem. Any five leaves joined in succession according to age are arranged in a spiral of two revolutions, and every fifth leaf will occupy corresponding positions (first, sixth, eleventh, etc., or second, seventh, twelfth, etc.).

Charles Darwin once wrote to Asa Gray that he could spare him from an uneasy grave by explaining why different plants have leaves spaced in varying spiral arrangements.

A thoughtful discussion of phyllotaxy in evolution is provided by Wagner (Florida State Univ. Studies 13: 48-71. 1954). He (following Fleischer) divided the Neckeraceae into two subfamilies: the Neckeroideae, with leaves inserted in eight rows, and the Homalioideae, with leaves inserted in four rows. However, Touw (Blumea 11: 373-425. 1962) showed that all the Neckeraceae could be interpreted as having an 8-ranked phyllotaxy, sometimes apparently 4-ranked because of complanation, asymmetry, and differential curvature of leaves. Information on distichous and pseudodistichous leaf arrangements provided earlier by van der Wijk (Acta Bot. Neerl. 6: 386-391. 1957) support Touw's interpretations.

## FABRONIACEAE

Small or very small plants in green or yellowish, dull or shiny mats. Stems creeping, radiculose in scattered tufts, freely branched; branches ascending; paraphyllia

usually none. Leaves crowded, appressed when dry, spreading on all sides or rarely secund when moist, ± concave, ovate or lanceolate, mostly long-acuminate, usually not decurrent, neither bordered nor plicate; costa single and slender, rather short (never percurrent), rarely lacking; cells mostly prosenchymatous, mostly thin-walled, smooth, quadrate or oblate-oblong at the basal angles. Perichaetia lateral; perichaetial leaves rarely sheathing. Setae elongate; capsules erect and symmetric, oblong-cylindric, with a short, thick neck, often longitudinally wrinkled and sometimes constricted below the mouth when dry; annulus persistent and apparently lacking or rarely deciduous; operculum broad and umbonate or conic, sometimes rostrate; exothecial cells lax and thin-walled, sometimes with very irregular walls; peristome single (either the endostome or rarely the exostome lacking) or double, the teeth 16 (often united in pairs before dehiscence), flat, without trabeculae, rarely bordered; endostome, if present, consisting of subulate segments only or sometimes of a basal membrane and keeled segments. Calyptra cucullate, usually naked.

### **Anacamptodon** Brid.

Small plants in dense, dark-green or yellowish mats. Stems creeping, somewhat radiculose, freely and irregularly branched; branches ± ascending. Leaves erect and ± homomallous when dry, spreading or subsecund when moist, moderately concave, gradually acuminate from an ovate or oblong-ovate base; margins erect and entire; costa single, ending at or above the leaf middle; cells green, oblong-rhombic to shortly oblong-rhomboidal above, rectangular at base, not much differentiated at the basal margins. Autoicous; perichaetial leaves somewhat elongate, loosely erect, lance-acuminate, with a slender costa and elongate cells. Setae elongate, straight, rather stout, smooth; capsules erect and symmetric, oblong-cylindric, strongly contracted below the mouth and at the distinct neck when dry; annulus narrow; operculum convex, stoutly and obliquely apiculate to short-rostrate; stomata superficial, in the neck; exothecial cells hexagonal, with straight wells; peristome teeth inserted somewhat below the mouth, strongly recurved when dry, yellow-brown, lanceolate, densely and finely papillose; endostome consisting of linear, smooth, red-brown segments about 1/2-2/3 as long as the teeth and alternating with them. Spores spherical. Calyptrae smooth, naked.—The name means that the teeth of the peristome are bent backward.

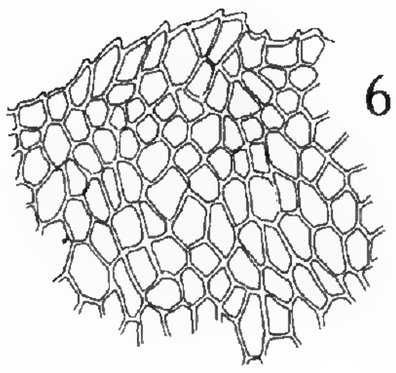
**Anacamptodon splachnoides** (Froel. *ex* Brid.) Brid.—Leaves about 1 mm. long; costa 1/2-2/3 the leaf length (or sometimes shorter); upper cells oblong-rhombic to shortly oblong-rhomboidal, about 13 $\mu$ wide and 2.5-4:1. Setae 8-12 mm. long, yellow-brown or orange-red; capsules 1-2 mm. long, yellow-brown, shiny-orange at the wide mouth when dry. Spores 9-11 $\mu$, faintly roughened to very finely papillose.

Breen, Mosses of Florida, Pl. 116. Darlington, Mosses of Michigan, fig. 102. Grout, Mosses with Hand-lens and Microscope, fig. 210. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 33, (ed. 2) Pl. 37. Welch, Mosses of Indiana, fig. 242.—**Fig. 631-634.**

On the bark of trees, particularly in the protection of crotches, fissures, or knotholes, rarely on logs or stumps. Central Europe; widespread (but uncommon) in eastern North America.

CHEBOYGAN CO.—Colonial Point. EMMET CO.—Pellston Hills, Cross Village. MACKINAC CO.—Mackinac Island.

The gametophytes are dark-green and nondescript in appearance, somewhat resembling an *Amblystegium* on a larger scale. The capsules are erect, and a deep constriction just below the mouth is made the more conspicuous by closely recurved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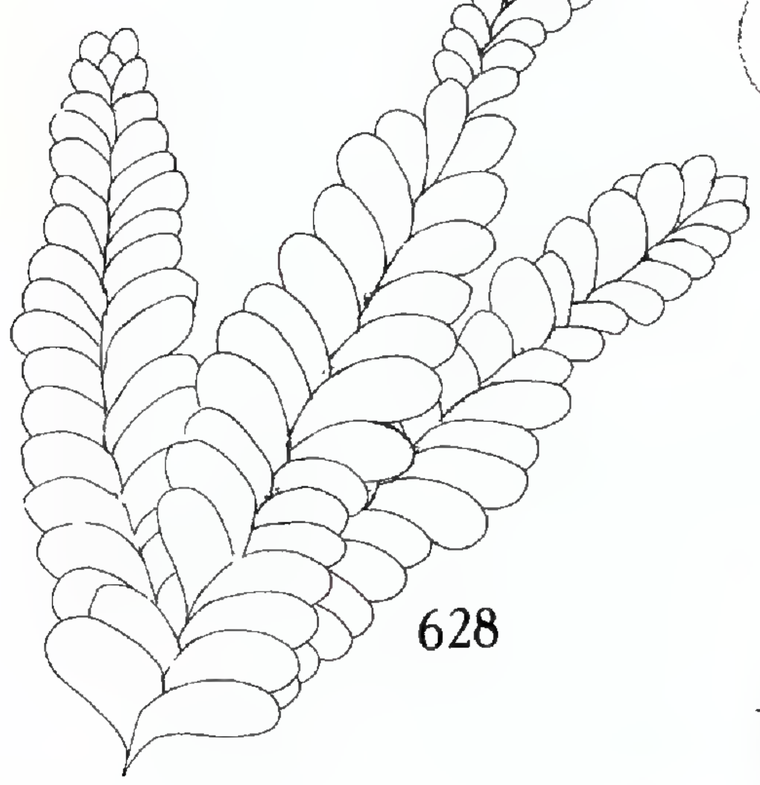
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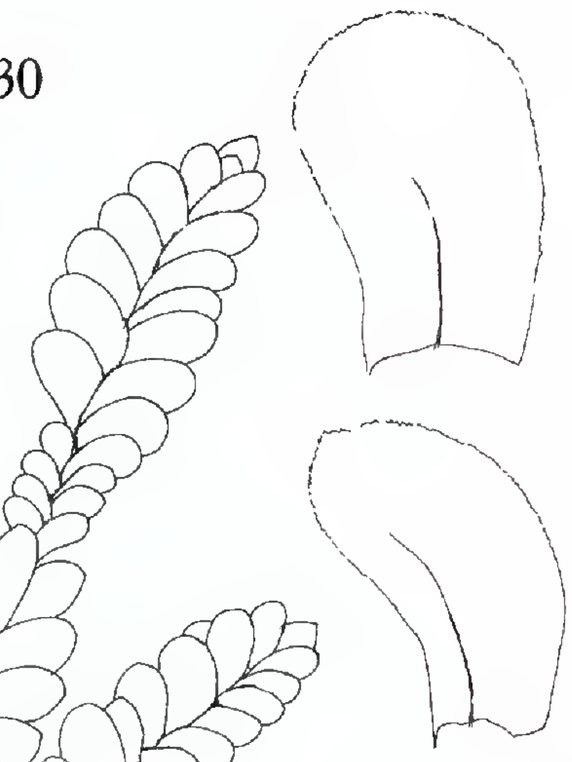
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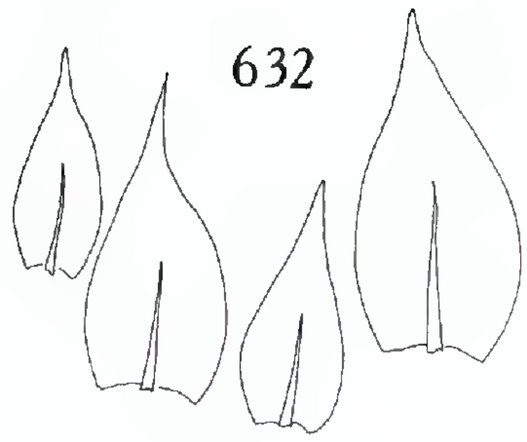
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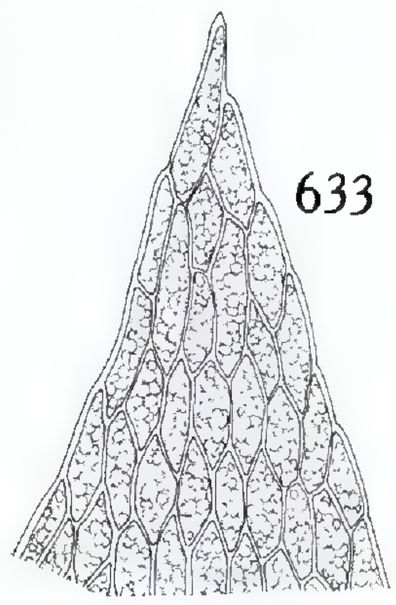
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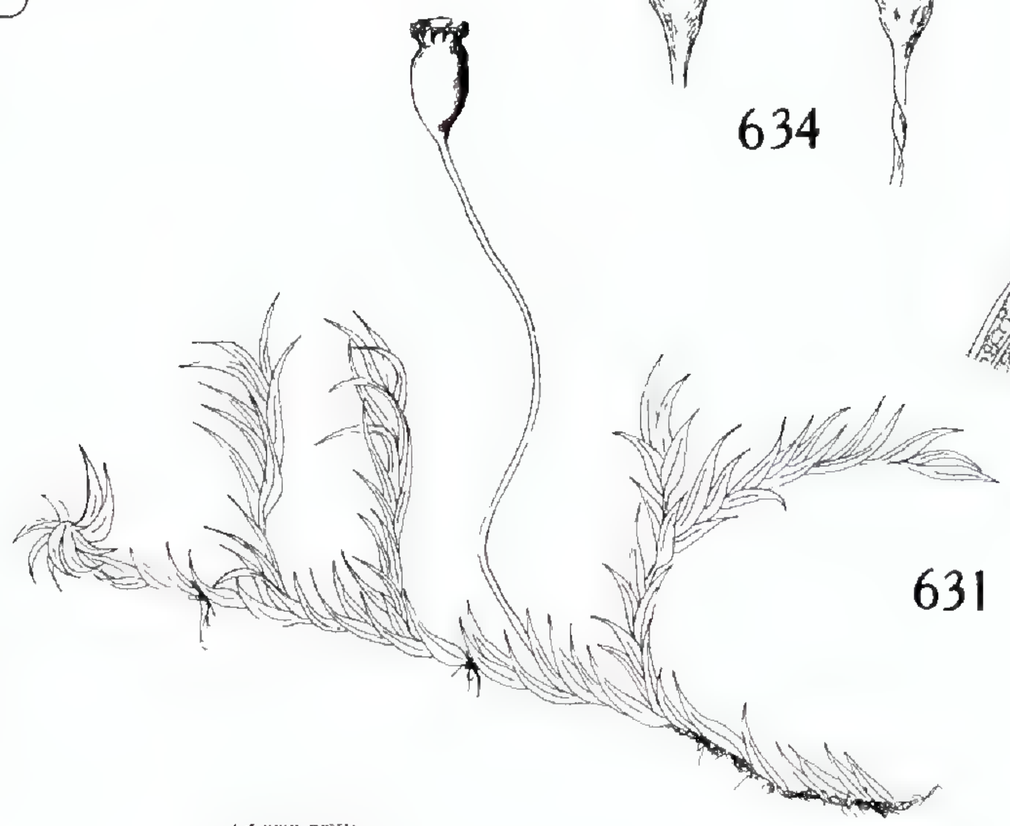
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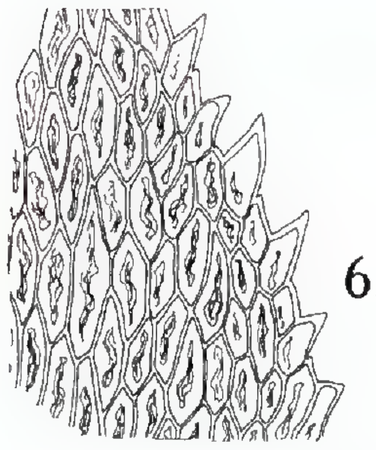
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636

*Homalia trichomanoides.* 628. Habit. 629. Leaves. 630. Cells at leaf apex.
*Anacamptodon splachnoides.* 631. Habit. 632. Leaves. 633. Cells at leaf tip. 634. Capsules, wet and dry.
*Fabronia ciliaris.* 635. Habit. 636. Leaves. 637. Cells of upper portion of leaf.

peristome teeth. The specific name no doubt refers to the recurved peristome, as any other resemblance to the genus *Splachnum* seems remote. The "primordial utricle" is a conspicuous feature of the leaf cells. (On drying the plasma membrane becomes withdrawn from the cell walls, and even on soaking the cell contents remain collapsed and give the leaves a microscopic effect of blurred opacity, reminding me of soapy water.) The KNOTHOLE MOSS grows especially on moist, rotten bark, often indeed in knotholes.

Other members of the family found as rarities in the southern part of the state are **Fabronia ciliaris** (Brid.) Brid. (fig. 635-637) and **Schwetschkeopsis fabronia** (Schwaegr.) Broth. (fig. 638-640). Both are very small and grow on bark of trees.

## LESKEACEAE

Plants slender to fairly robust, in loose or dense, mostly dull and rigid, dark, green or brownish mats. Stems creeping or sometimes arched or ascending, irregularly to pinnately branched (sometimes 2-3-pinnate in flat fronds); paraphyllia very abundant or sparse to lacking. Stem and branch leaves often differentiated, ovate or ovate-lanceolate, blunt or acute to acuminate; costa single and strong, rarely short and double or lacking; cells subquadrate or rounded-hexagonal to rhombic, rarely rhomboidal, smooth or variously papillose, rarely mammillose. Perichaetia lateral; perichaetial leaves differentiated. Setae elongate, mostly smooth; capsules erect and symmetric or inclined to horizontal and asymmetric, cylindric or oblong-cylindric; annulus generally present; operculum bluntly conic to rostrate; stomata usually present; peristome double, various in form, inserted far below the mouth with the endostome much longer than the exostome (in *Rhegmatodon*) or inserted mostly at or near the mouth with the endostome nearly as long as the exostome, the 16 teeth lanceolate, blunt to subulate, smooth, papillose, or variously striolate, sometimes bordered, mostly trabeculate; basal membrane of the endostome low to high, segments well developed and often keeled or sometimes narrow, irregular, or lacking, cilia rudimentary or lacking to well developed. Spores spherical. Calyptrae mostly cucullate, usually naked.—For convenience, the family is presented here in a most inclusive sense, corresponding to the Theliaceae, Leskeaceae, and Thuidiaceae of some authors. Either treatment is artificial, arbitrary, and unsatisfactory as a phyletic grouping. A better arrangement is suggested, as follows:

My tentative concept of the Leskeaceae calls for capsules erect and symmetric with peristomes variously developed but not hypnaceous. By contrast, the Thuidiaceae have mostly inclined and asymmetric capsules and perfect hypnaceous peristomes (*i.e.*, with exostome teeth cross-striolate and endostome consisting of keeled segments—and usually well-developed cilia—from a high basal membrane). I would group the North American genera as follows: LESKEACEAE (*Leskea, Leskeella, Lescuraea, Pterigynandrum, Lindbergia, Thelia, Haplohymenium, Anomodon, Herpetineurum*) and THUIDIACEAE (*Pseudoleskeella, Pseudoleskea, Myurella, Heterocladium, Haplocladium, Thuidium, Helodium*). I would dispense with the Theliaceae. Whether *Pterigynandrum* and *Myurella* are properly placed is debatable. *Rhegmatodon* is excluded, as probably worth familial distinction.

1. Costa short and usually double or none
   2. Plants subpinnately branched; stem and branch leaves differentiated; capsules inclined and asymmetric — 5. *Heterocladium*
   2. Plants irregularly branched; stem and branch leaves similar; capsules erect and symmetric
      3. Plants freely branched; stems and branches slenderly terete or filiform; peristome teeth variously striolate below, smooth above; endostome consisting of linear, unequal segments — 4. *Pterigynandrum*
      3. Plants simple or sparsely branched; stems and branches julaceous or terete but not filiform; peristome teeth cross-striolate below, papillose above; endostome consisting of a well-developed basal membrane, keeled segments, and short or elongate cilia — 3. *Myurella*

1. Costa well developed, single
   4. Leaf cells smooth — 2. *Leskeella*
   4. Leaf cells obscurely bulging-papillose to conspicuously uni- to pluripapillose
      5. Paraphyllia none or very few and inconspicuous; plants irregularly branched
         6. Stems differentiated from branches, creeping, filiform, with reduced leaves; leaf cells pluripapillose — 6. *Anomodon*
         6. Stems and branches not much differentiated, with similar leaves; cells obscurely bulging-papillose to distinctly unipapillose
            7. Plants scattered or in loose, thin mats; brood branchlets common in axillary clusters; leaves abruptly narrowed to a short, pale or yellowish awn-like acumen; cells distinctly unipapillose — 8. *Lindbergia*

7. Plants in dense mats; brood branches none; leaves gradually narrowed to an acute or obtuse apex; cells obscurely bulging on both surfaces (especially at back) 1. *Leskea*

5. Paraphyllia numerous or abundant; plants pinnate (and usually very obviously so)

8. Paraphyllia filiform, very numerous and felted 11. *Helodium*

8. Paraphyllia polymorphous, not filiform, not felted

9. Apical cell of branch leaves with 2 or more papillae and truncate; plants regularly 1-3-pinnate and frondose; paraphyllia very abundant 10. *Thuidium*

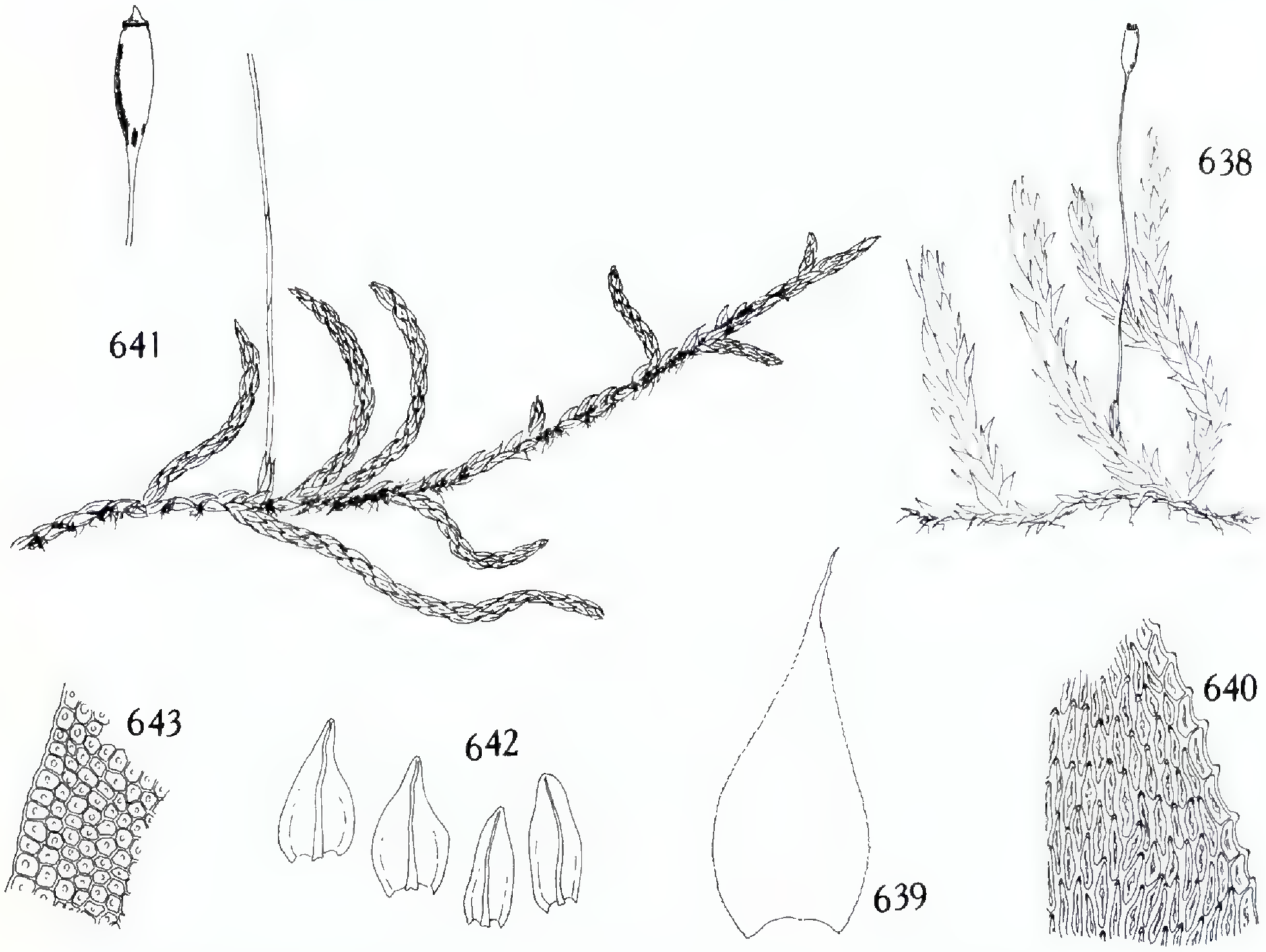
9. Apical cell of branch leaves unipapillose and sharply pointed; plants 1-pinnate, not frondose; paraphyllia fairly numerous

10. Plants loosely subpinnate; branches not julaceous; leaves not crowded; leaf cells with a single, low papilla at back; capsules inclined and asymmetric 9. *Haplocladium*

10. Plants closely and regularly pinnate; branches julaceous; leaves crowded; leaf cells stoutly unipapillose; capsules erect and symmetric 7. *Thelia*

## 1. **Leskea** Hedw.

Rather small plants in dull, dark-green or brownish mats. Stems creeping, sparsely radiculose, freely to subpinnately branched; branches horizontal or ascending; paraphyllia few, linear-lanceolate. Stem and branch leaves not much differentiated. Leaves erect or somewhat incurved when dry, erect-spreading or spreading when moist, somewhat asymmetric, oblong-ovate to ovate-lanceolate, sometimes biplicate at base; margins plane or ± recurved below, entire or subserrulate above; costa subpercurrent or ending somewhat below the apex, often flexuose-curved above; upper cells small, irregularly quadrate-hexagonal, thick-walled, obscure, ± unipapillose at back or on both surfaces; lower cells somewhat longer, those toward the margins subquadrate; Autoicous; perichaetial leaves elongate, erect, pale-brown, acuminate. Setae smooth; capsules erect and symmetric or somewhat curved, cylindric or oblong-cylindric;




*Schwetschkeopsis fabronia*. 638. Habit. 639. Leaf. 640. Upper cells of leaf.
*Leskea gracilescens*. 641. Habit. 642. Leaves. 643. Upper cells of leaf.

annulus narrow; operculum bluntly conic; stomata few, at base of capsule; peristome teeth incurved when dry, linear-lanceolate, whitish or yellow, densely papillose throughout or, more often, cross-striolate near the base; endostome erect wet or dry, pale, papillose, consisting of a low basal membrane, long, linear, somewhat keeled, perforate segments (sometimes rudimentary), and cilia none or rudimentary. Calyptra cucullate, smooth, naked.—Named for Professor Gottfried Leske of Leipzig.

**Leskea gracilescens** Hedw.—Branches spreading. Stem leaves 0.6-0.8 mm. long. Branch leaves usually ± crowded, rather rigid and erect or somewhat incurved-erect when dry, erect-spreading when moist, 0.4-0.5 mm. long, ovate or ovate-lanceolate, acute or sometimes bluntly pointed, ± biplicate at base; margins irregularly revolute in the lower ½ or more (especially when dry); costa ending near the apex; upper cells 7-11 $\mu$, obscurely bulging on both surfaces, but especially at back. Setae 5-8 mm. long, yellow-brown, becoming orange-brown to reddish with age; capsules 1.5-2.2 mm. long, oblong-cylindric, straight (or sometimes somewhat curved before dehiscence); peristome teeth pale, yellowish or brownish-yellow, cross-striolate at base; segments somewhat shorter than the teeth. Spores 12-14 $\mu$, very finely papillose.—n = 10+1, 11.

Conard, How to Know the Mosses, (ed. 1) fig. 129a-c, (ed. 2) fig. 188a-c. Grout, Moss Flora of North America 3: Pl. 71B.—**Fig. 641-643.**

Found only once in the Straits area, on a roadside maple four miles west of Van in Emmet County. It is common in more southern parts of Michigan and occurs in nearby Alpena County. Widespread in eastern North America.

The species of *Leskea* are not well marked, and their names have been much misused: **L. polycarpa** Hedw., not known from Michigan (though wide-ranging and to be expected here) has leaves somewhat longer than wide and somewhat oblique and subsecund at the tips, and the capsules are subcylindric and curved. **Leskea obscura** Hedw., which has been found in southernmost Michigan, differs from *L. gracilescens* in having broad, concave, non-plicate leaves, rounded or rounded-obtuse at the apex, and erect at the margins.

*Pseudoleskea* is somewhat similar to *Leskea* in appearance but occurs on rock in upland habitats in montane areas. The paraphyllia are numerous, the inflorescences dioicous, and the peristomes hypnaceous in structure and ornamentation. In Keweenaw Co., we have **P. patens** (Lindb.) Kindb. It has leaf cells isodiametric, with a central papilla on either surface. In Keweenaw and Ontonagon Counties, we have **P. radicosa** (Mitt.) Macoun & Kindb. Its leaf cells are somewhat elongate (2-3:1) with those toward the leaf tips papillose on the upper surface because of projecting upper ends. (It is most unusual for such papillae to occur on the upper surface.)

## 2. **Leskeella** (Limpr.) Loeske

Slender plants in loose or dense, dull, dark-green or brown, rigid mats. Stems creeping, subpinnately branched; paraphyllia none. Stem and branch leaves somewhat differentiated. Stem leaves erect or appressed when dry, erect-spreading when moist, rather abruptly subulate from an ovate-lanceolate base; margins narrowly recurved below, entire or occasionally slightly serrulate near the tip; costa nearly filling the subula and percurrent or nearly so; cells small and dark, smooth, thick-walled, rounded or slightly elongate in the upper median region, usually somewhat elongate in the subula, oblate-quadrate in numerous rows at the basal angles. Branch leaves shorter, gradually acuminate or sometimes acute or rarely bluntly acute, with the costa shorter,

ending somewhat below the apex and not filling most of the subula. Dioicous; perichaetial leaves pale, erect, elongate, slenderly acuminate from a sheathing base. Setae elongate, smooth; capsules erect and symmetric or slightly curved, oblong-cylindric, brownish; annulus narrow; operculum stoutly and obliquely short-rostrate from a convex-conic base; stomata at base of the capsule; peristome teeth inserted near the mouth, erect, yellowish, lanceolate, acuminate, transversely and obliquely striolate below, smooth or papillose above; endostome pale, finely papillose, the basal membrane moderately high, segments irregular, fragmentary or filiform, rarely lanceolate and keeled, cilia none or rudimentary. Calyptrae cucullate, smooth, naked.—A diminutive of *Leskea*.

**Leskeella nervosa** (Brid.) Loeske—Plants nearly always producing dense, axillary clusters of brood-branchlets (or mere buds). Stem leaves 0.8-1 mm. long, entire or rarely somewhat serrulate at the apex; costa smooth at back; upper median cells 7-9 $\mu$ wide, rounded or somewhat elongate, those in the acumen about 1.5-2:1. Branch leaves 0.4-0.6(0.8) mm. long, subulate to acute (rarely bluntly acute). Setae 9-15 mm. long; capsules 1.5-2.5 mm. long; annulus of 2 rows of cells; peristome teeth smooth above; segments of endostome irregular or rudimentary, the cilia none or delicate and irregular. Spores 13-17 $\mu$, very finely papillose.

Grout, Mosses with Hand-lens and Microscope, Pl. 57 (figs. 41-54), as *Leskea*. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 35, (ed. 2) Pl. 39.—**Fig. 644-646.**

On bark of trees (especially at base) and on rock, often on brush or old logs in dry or fairly moist, shady places. Circumpolar; Alaska to Labrador, south to Pennsylvania, Michigan, Colorado, and Arizona.

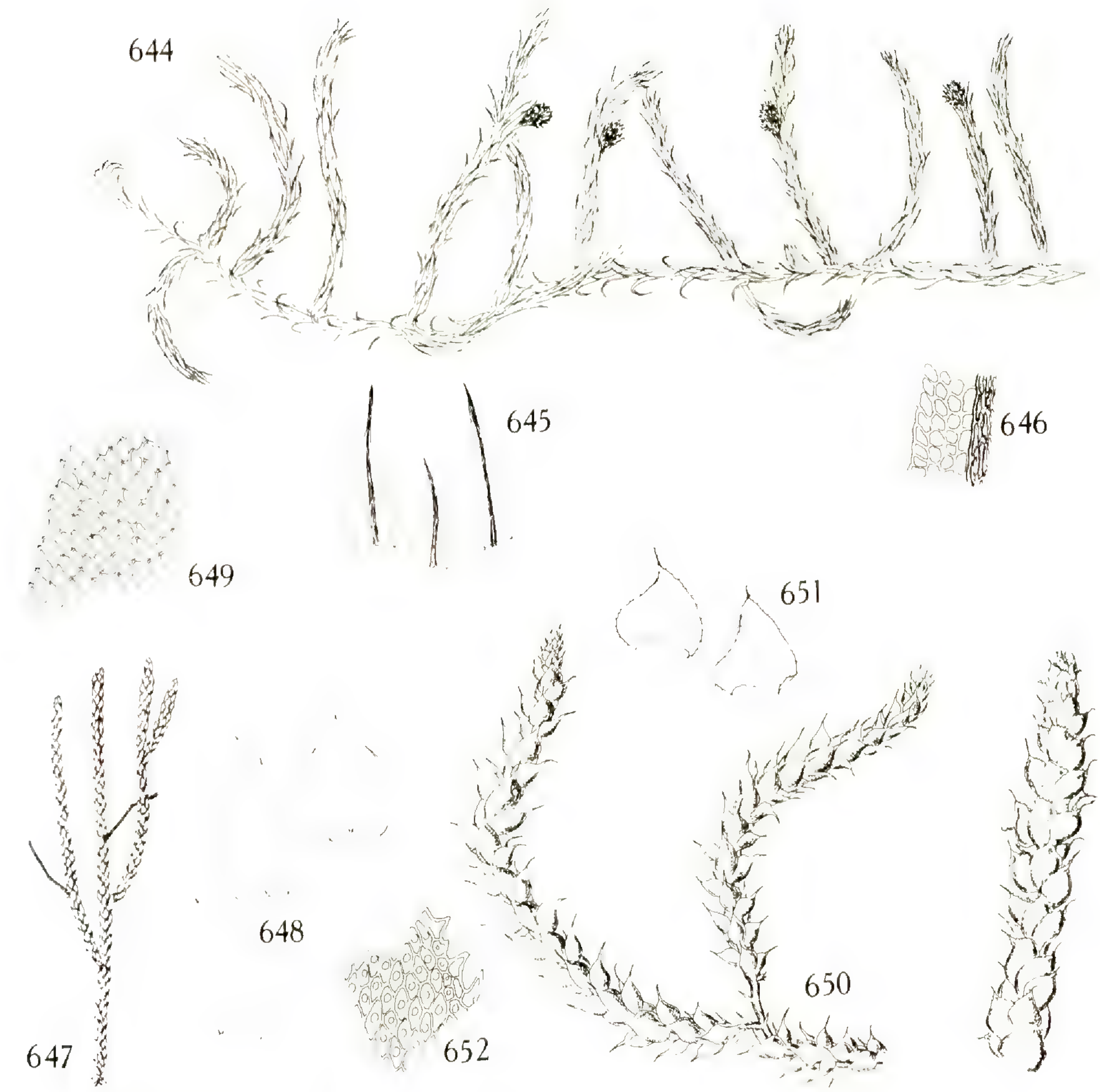
CHEBOYGAN CO.—South Fishtail Bay and Polypody Bluff (both at Douglas Lake), Gorge of Carp Creek, Iron Bridge, Beavertail Creek, Colonial Point, Mill Creek. EMMET CO.—Levering, Maple River, Cross Village, Middle Village, Five Mile Creek, Cecil Bay, Big Stone Creek. MACKINAC CO.—Mackinac Island, McKays Creek, Gros Cap, Caffey Corner, Ozark. PRESQUE ISLE CO.—Rainy River Falls, Hoeft State Park, Evergreen Beach.

A very common moss resembling *Platygyrium repens* in the production of branchlets in axillary clusters but distinguished by smaller size, dull, dark-green or blackish color, and leaves tapered to narrow tips more or less filled by the single costa.

The single local record of **Pseudoleskeella tectorum** (Funck *ex* Brid.) Kindb. *ex* Broth. (South Fishtail Bay, Douglas Lake, *C. B. Arzeni*) is geographically and ecologically unlikely. It is a saxicolous moss of the Rocky Mountains and a few outlying localities in the East, in the Lake Superior region of Michigan (Keweenaw Co.) and a few places in Ontario and Quebec. It is similar in some ways to *Leskeella nervosa* and sometimes produces deciduous, flagellate branches. It differs most notably in the variable costa, usually ending at or below the middle but often nearly lacking and sometimes extending as much as two-thirds the leaf length. Also, the peristome is hypnaceous in character.

### 3. **Myurella** BSG

Small plants in loose or dense, light- or yellow-green, often grayish or bluish mats or cushions, rigid when dry. Stems crowded and erect-ascending or looser and creeping, forked or irregularly branched, often ± stoloniform-attenuate, somewhat radiculose in scattered tufts; branches terete, sometimes julaceous, blunt or tapered; paraphyllia none. Leaves crowded and imbricate or less crowded and erect- to wide-spreading, concave, rounded-ovate or broadly ovate, blunt or rounded-obtuse to abruptly




*Leskeella nervosa.* 644. Habit. 645. Leaves. 646. Upper cells of leaf.
*Myurella julacea.* 647. Habit. 648. Leaves. 649. Upper cells at margin of leaf.
*Myurella sibirica.* 650. Habit of plant and one branch at a slightly higher magnification. 651. Leaves. 652. Cells near apex of leaf.

apiculate or acuminate; margins erect, ± serrulate to strongly dentate; costa short and usually double, often indistinct or lacking; cells small and firm-or thick-walled, rhombic or elliptic-rhomboidal, smooth or papillose at back, centrally or because of projecting upper ends, shortly oblong near the insertion and irregularly and inconspicuously subquadrate toward the basal margins. Perichaetial leaves somewhat elongate, erect, lance-acuminate, toothed, red-brown, ecostate, with linear cells. Setae elongate, slender and flexuose, smooth; capsules erect and symmetric, oblong-obovoid from a distinct neck, yellow-brown, smooth; annulus well developed; operculum conic or conic-apiculate; stomata in the neck; peristome teeth lance-subulate, pale, yellow or yellow-brown and cross-striolate below, hyaline and papillose above, narrowly bordered, trabeculate; endostome pale, finely papillose, with a well-developed basal membrane, keeled segments, and short or elongate, single and paired cilia. Calyptrae cucullate, smooth, naked.–*Myurella* suggests a little mouse tail, alluding to the form of the branches, especially in *M. julacea.* A small genus of pretty little plants distinctive because of the terete or even julaceous, fragile stems and branches and their glaucous color.

Branches julaceous, blunt; leaves crowded and appressed, rounded-ovate, rounded or rounded-obtuse, occasionally short-apiculate, serrulate, papillose at back because of projecting upper cell ends (or rarely smooth) 1. *M. julacea*

Branches terete, tapered; leaves less crowded, erect- or wide-spreading, broadly ovate, abruptly apiculate to acuminate, dentate, stoutly unipapillose at back of the lumina 2. *M. sibirica*

1. **Myurella julacea** (Schwaegr.) BSG—Plants light-green, pale, yellowish or greenish and glaucous. Branches julaceous, blunt. Leaves crowded, imbricate wet or dry, faintly striolate when dry, 0.3-0.5 mm. long, rounded-ovate, rounded or rounded-obtuse and occasionally short-apiculate; margins serrulate all around; costa faint or lacking; upper cells irregularly rhombic, papillose at back because of projecting upper ends (or sometimes smooth). Dioicous. Setae 6-15 mm. long, orange-yellow; capsules 1-1.2 mm. long; endostome segments perforate; cilia short, stout, single or paired. Spores 9-11 $\mu$, very finely roughened.

Darlington, Mosses of Michigan, fig. 100. Grout, Moss Flora of North America 3: Pl. 50 left.—**Fig. 647-649.**

Generally in crevices of shaded, moist cliffs, sometimes on soil or humus, especially at base of trees or on banks of brooks, apparently preferring calcareous habitats. Circumpolar; Greenland to Alaska, south to New York, Wisconsin, Colorado, and Oregon.

CHEBOYGAN CO.—East of Levering, Pine Point (Douglas Lake). Bryants Bog, Mill Creek, Duncan Bay, Grass Bay, Black Lake. EMMET CO.—Cecil Bay, Big Stone Creek. MACKINAC CO.—Bois Blanc Island, Bush Bay. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Clinton Lake.

2. **Myurella sibirica** (C. M.) Reim.—Plants light- or yellow-green to glaucous. Branches terete, often somewhat flagellate-attenuate. Leaves usually not crowded, loosely erect- to wide-spreading, 0.35-0.6 mm. long, broadly ovate, abruptly narrowed to a long apiculus or a short, slender, flexuose acumen; margins irregularly dentate to spinulose-dentate all around; costa short and double, often indistinct, frequently 1 fork longer and extending about 1/3 the leaf length; cells rhombic, each bearing a single large papilla over the lumen at back. Dioicous. Setae about 10-12 mm. long, becoming red; capsules about 0.8-1 mm. long; endostome segments not perforate; cilia well developed, ± nodulose, single or paired. Spores 11 $\mu$, smooth or very finely papillose.

Conard, How to Know the Mosses, (ed. 2) fig. 176 (as *M. careyana*). Grout, Moss Flora of North America 3: Pl. 51B (as *M. careyana*). Welch, Mosses of Indiana, fig. 229 (as *M. careyana*).—**Fig. 650-652.**

Typically in deeply shaded, moist niches and crevices of cliffs, sometimes on protected soil of banks or sides of damp logs, often in calcareous habitats. Circumpolar (but apparently rare in northern Eurasia; Nova Scotia to Minnesota, south to North Carolina and Arkansas.

CHEBOYGAN CO.—Mill Creek, Black Lake. MACKINAC CO.—Mackinac Island. PRESQUE ISLE CO.—Evergreen Beach.

## 4. **Pterigynandrum** Hedw.

Plants very slender to small or medium-sized, in loose or dense, sometimes shiny, green, yellowish, or brownish mats. Stems creeping or curved-ascending, freely and irregularly branched; branches terete and often nearly filiform, frequently curved; paraphyllia none or very few at the branch insertions. Leaves erect or imbricate and sometimes ± homomallous, concave, elliptic or oblong-ovate, sharply or bluntly acute, shortly decurrent; margins narrowly reflexed in the lower half, serrulate above; costa

short and double; cells mostly rather short, oblong-rhombic to oblong-rhomboidal, flexuose, generally thick-walled, papillose at back because of thickened and projecting ends; alar cells small and subquadrate in few to several rows, forming small and inconspicuous groups. Dioicous; perichaetial leaves pale and erect, broadly lanceolate, gradually acuminate, entire. Setae elongate, smooth; capsules erect and symmetric, cylindric; annulus well developed; operculum conic-rostrate; stomata in the neck; peristome teeth rather short, lanceolate, pale, yellow-brown and variously striolate (obliquely, transversely, and vertically) below, hyaline and smooth above, not trabeculate; endostome hyaline, smooth, consisting of stoutly linear segments, unequal, short or sometimes nearly as long as the teeth. Calyptrae cucullate, smooth, naked.–Named by Hedwig presumably in reference to lateral inflorescences (at the side or in the "wings").

**Pterigynandrum filiforme** Hedw.–Small, slender plants in low, dull, dark-green, yellowish, or brownish mats; branches terete or julaceous, often curved, frequently slender and nearly filiform; brood-bodies common in leaf axils, small, stalked, ovoid, golden-brown, 2-celled. Stem leaves crowded, erect or imbricate, about 0.6-1 mm. long, broadly ovate or elliptic, gradually or rather abruptly narrowed to a sharp or rather blunt, acute point; costae rarely ¼ or more the leaf length; cells oblong-rhombic to oblong-rhomboidal, thick-walled, coarsely papillose at back; alar cells subquadrate in few to several rows. Branch leaves similar but smaller. Setae 5-15 mm. long, yellow-brown to orange; capsules 1-2.5 mm. long, yellow-brown; operculum stoutly long-rostrate. Spores 11-13 $\mu$, very finely papillose.

Darlington, Mosses of Michigan, fig. 106. Grout, Mosses with Hand-lens and Microscope, fig. 134.–**Fig. 653-656.**

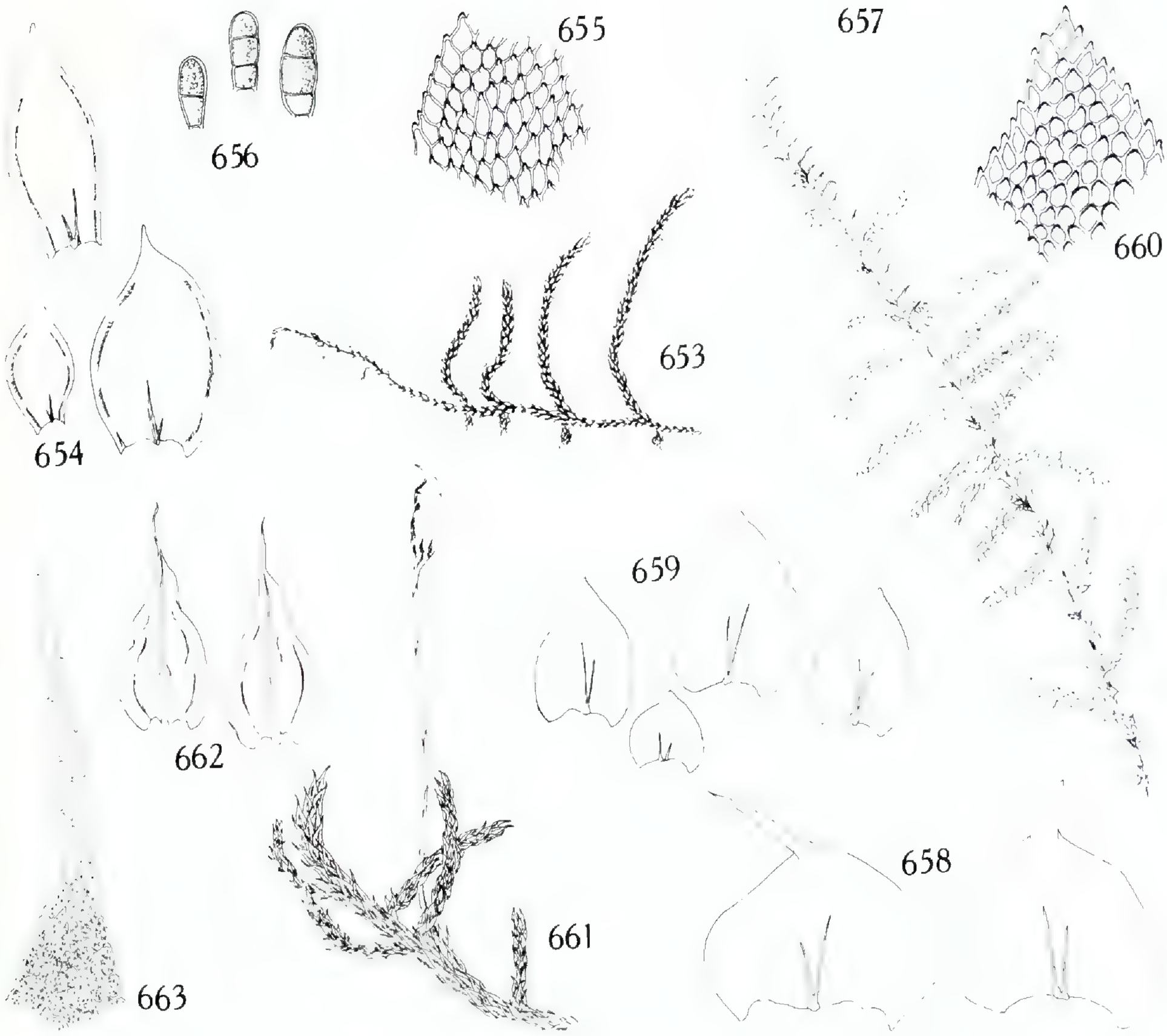
On dry, shaded rocks or sometimes on bark of exposed roots or bases of trees. Circumpolar; Alaska to California and Montana, also Quebec and New Hampshire to North Carolina and the Great Lakes region.

CHEBOYGAN CO.–Lake bluff near Bryants Bog.

The brood-bodies, so commonly produced in leaf axils, were described and illustrated by Crum (Bryol. 56: 98-100. 1953). They had been reported earlier from Switzerland and formed the basis for Wheldon's var. *montanense* (Rev. Bryol. 32: 7-8. 1905).

## 5. **Heterocladium** BSG

Plants small to moderate in size, in flat, mostly dull, dark-green to yellow-brown mats. Stems creeping, subpinnately branched, stoloniform at the ends; paraphyllia very few; pseudoparaphyllia present. Leaves dimorphous, not plicate. Stem leaves erect-spreading to squarrose, gradually or abruptly narrowed to a slender acumen from a sheathing, cordate-ovate, narrowly decurrent base; margins plane, serrulate all around; costa short and indistinct, forked or double, sometimes single; cells elongate throughout or oblong-linear in the middle of the leaf base and small and hexagonal to rhombic toward the margins and above, smooth or papillose with 1-several small papillae. Branch leaves small, broadly ovate, acute to blunt or rounded-obtuse, often imbricate or secund, with short upper cells. Dioicous; perichaetial leaves pale, erect at base, with spreading to squarrose acumina. Setae elongate; capsules strongly inclined to horizontal, curved, oblong-cylindric, short-necked, constricted below the mouth when dry; annulus differentiated; operculum convex-conic, blunt or rostrate; peristome teeth fused at base, lance-subulate, yellow-brown and cross-striolate below, pale and papillose




*Pterygynandrum filiforme.* 653. Habit. 654. Leaves. 655. Upper cells at margin of leaf. 656. Brood-bodies.

*Heterocladium dimorphum.* 657. Habit. 658. Stem leaves. 659. Branch leaves. 660. Upper cells of branch leaf.

*Anomodon rostratus.* 661. Habit. 662. Branch leaves. 663. Cells at tip of branch leaf.

above, bordered, trabeculate; endostome pale and finely papillose, with a high basal membrane, keeled and narrowly perforate segments, and well-developed, nodulose cilia in groups of 1-3. Calyptrae cucullate, smooth, naked.—The name translates as different branch, referring to the differentiated stem and branch leaves.

**Heterocladium dimorphum** (Brid.) BSG—Rather small plants in loose or dense, rigid, dark-green to yellow-brown mats. Stems loosely pinnate. Stem leaves about 0.7-1 mm. long, pale, rather abruptly narrowed to a slender, loosely spreading to recurved acumen from an erect, cordate-ovate base; costa double, very slender and often indistinct but usually 1/3-1/2 or slightly more the length of the leaf; cells rhombic to oblong-rhombic, thick-walled, and unipapillose at back because of projecting upper ends; cells of the base oblong or oblong-linear, thick-walled, pale, smooth, those toward the margins small, subquadrate to short-rhombic, and papillose. Branch leaves smaller, imbricate when dry, wide-spreading when moist, rounded- or oblong-ovate, acute or (especially toward the branch tips) rounded at the apex, serrulate nearly all around; costa short and indistinct or up to ½ the leaf length, sometimes single; upper and basal marginal cells small, hexagonal to short-rhombic, thick-walled, unipapillose at back because of projecting upper ends. Setae 13-16 mm.

long, flexuose, red-yellow to orange-red, smooth; capsules 1.2-2 mm. long; annulus of 2 rows of cells, deciduous in fragments; operculum blunt; stomata few and small, at base of capsule; cilia of endostome 1-3. Spores 13-15 $\mu$, very finely papillose.

Darlington, Mosses of Michigan, fig. 109 (as *H. squarrosulum*). Grout, Moss Flora of North America 3: Pl. 48 (figs. 18-40), as *H. squarrosulum*.–**Fig. 657-660.**

On soil, humus, rocks, or bases of trees and stumps in moist woods, particularly on steep banks of streams. Europe and the Caucasus; British Columbia to Oregon and Montana; Newfoundland to Michigan and New York; also reported from Greenland.

CHEBOYGAN CO.–Grapevine Point (Douglas Lake). EMMET CO.–Big Stone Bay.

## 6. **Anomodon** Hook. & Tayl.

Fairly robust plants in loose or dense, dull, rigid, dark- or glaucous-green, yellowish, or brownish mats or cushions, sparsely radiculose. Primary stems filiform, creeping, often stoloniferous, with small leaves and numerous, spreading or erect-ascending, often curved, simple or branched, frequently slender or tapered secondary stems; paraphyllia none. Leaves of secondary stems and branches similar, crowded in numerous rows, erect or imbricate or sometimes incurved-contorted when dry, erect to wide-spreading when moist, rarely subsecund, lingulate, lanceolate, or lance-acuminate from a broad, oblong or ovate, generally broadly decurrent base, obtuse or rounded to acute or acuminate; margins mostly plane and entire or nearly so; costa strong, flexuose, yellow, mostly ending well below the apex; cells mostly small, hexagonal, thin-walled, green, obscure, and densely pluripapillose to the base (but rarely coarsely unipapillose or longer, rhombic, and smooth throughout); cells at middle of insertion oblong, incrassate, smooth, and pellucid. Dioicous; perichaetial leaves moderately elongate, sheathing at base, little differentiated above or pale, spreading, and subulate with elongate cells. Setae generally elongate and flexuose, smooth; capsules usually clearly exserted, erect and symmetric, cylindric, oblong-cylindric, or sometimes ovoid, smooth or sometimes indistinctly wrinkled-striate when old; annulus mostly differentiated; operculum conic, sometimes rostrate; stomata none or few and small at the extreme base of the urn; peristome teeth inserted near the mouth on a low membrane, narrowly lanceolate, pale white to yellowish or brownish, densely papillose, rarely weakly cross-striolate at base, not or only weakly trabeculate, usually not bordered; endostome pale, finely papillose, consisting of a low basal membrane, rudimentary to fairly well-developed, linear, somewhat keeled segments, and cilia short and rudimentary or none. Calyptrae cucullate, smooth (or rarely papillose above), naked.–The name *Anomodon* signifies an abnormal peristome. It was based on a faulty interpretation of the segments of the endostome as arising between the teeth of the exostome, rather than from an inner peristomial layer as in Bridel's concept of *Neckera* (and, indeed, in all mosses with a double peristome).

1. Leaves ending in a short or long, hyaline hair-point; margins revolute — 1. *A. rostratus*
1. Leaves not ending in a hair-point; margins plane
  2. Secondary stems spreading, freely branched, with many branches conspicuously tapered to stoloniform-attenuate; leaves acute and mostly apiculate — 2. *A. attenuatus*
  2. Secondary stems ascending, less freely branched, with branches often slender but not particularly attenuate; leaves broadly pointed, obtuse, rounded-obtuse, or broadly rounded
    3. Leaves erect or imbricate and scarcely contorted when dry — 3. *A. minor*
    3. Leaves erect and incurved-contorted when dry
      4. Leaves scarcely tapered from the shoulders to the rounded apex, rounded-auriculate at base — 4. *A. rugelii*
      4. Leaves tapered from the shoulders to the narrow, obtuse or rounded-obtuse apex, broadly decurrent — 5. *A. viticulosus*

1. **Anomodon rostratus** (Hedw.) Schimp.–Plants in yellowish, brownish-yellow, or sometimes dark-green, dense mats. Secondary stems and branches crowded and imbricate when dry, erect or erect-spreading when moist, ovate, acuminate, ending in a hyaline hair-point of varying length. margins usually revolute to the base of the acumen, papillose-crenulate; costa ending well below the apex. Setae (5)10-13 mm. long, red-brown, becoming blackish; capsules 1-1.5 mm. long, oval, oblong-cylindric, or occasionally cylindric, smooth, becoming dark-brown with age; annulus of 2 rows of cells, deciduous in fragments; operculum 0.8-1.1 mm. long, obliquely rostrate; stomata at the extreme base of the urn; peristome teeth pale yellowish or yellow-brown, becoming white, cross-striolate below; endostome segments not perforate, the cilia none or rudimentary. Spores green, very finely papillose or nearly smooth, 11-16 $\mu$. Calyptrae smooth.–n = 10+1, 11.

Breen, Mosses of Florida, Pl. 94 (figs. 3-4). Grout, Mosses with Hand-lens and Microscope, fig. 138. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 34, (ed. 2) Pl. 38. Welch, Mosses of Indiana, fig. 235.–**Fig. 661-663.**

On rock, soil, and bark at base of trees or sometimes stumps, in rather moist, shady places; probably preferring calcareous habitats. Europe; Bermuda, Haiti, Jamaica, Mexico, and Guatemala; widespread in eastern North America; Arizona.

CHEBOYGAN CO.–Colonial Point, Cheboygan, Mill Creek. EMMET CO.–Cecil Bay, Big Stone Bay. MACKINAC CO.–Mackinac Island, Hessel, McKays Creek, Bush Bay, Prentiss Bay, Ozark, Caffey Corner. PRESQUE ISLE CO.–Rainy River Falls, Clinton Lake.

Clearly distinguished from our other species by crowded, terete branches and ovate-acuminate leaves with hyaline hair-points.

2. **Anomodon attenuatus** (Hedw.) Hüb.–Plants in rather loose, dark-green or yellowish to brown mats. Secondary stems loosely spreading; branches usually decurved when dry, tapered or flagelliform-attenuate. Leaves curved and homomallous, loosely erect when dry, erect-spreading when moist, broadly oblong-lanceolate from an ovate, broadly decurrent base, acute and usually ending in a pale apiculus; margins plane, papillose-crenulate all around, often sparsely serrulate near the apiculus; costa ending well below the apex. Setae 13-27 mm. long; capsules 2-3 mm. long, cylindric, smooth, light-brown; annulus none; operculum 1.2-1.3 mm. long, obliquely rostrate; stomata at extreme base of urn; peristome teeth pale-yellow, becoming white, often faintly cross-striolate below, bordered; endostome segments often narrowly perforate along the keel, cilia rudimentary or none. Spores very finely papillose, 10-15 $\mu$. Calyptrae smooth.

Breen, Mosses of Florida, Pl. 97 (figs. 1-2). Grout, Mosses with Hand-lens and Microscope, figs. 135d, 137. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 34, (ed. 2) Pl. 38. Welch, Mosses of Indiana, fig. 234.–**Fig. 664-666.**

On bark, especially at the base of trees, also on logs, stumps, rocks, and sometimes soil; probably preferring calcareous habitats. Europe; Asia; Mexico, Guatemala, Cuba, and Jamaica; Colorado, New Mexico, and Arizona; widespread in eastern North America.

CHEBOYGAN CO.–Gorge of Carp Creek, Douglas Lake, Fontinalis Run, Bryants Bog, Mud Lake, Mill Creek, Mud Creek (at Black Lake). EMMET CO.–Maple River, Carp Lake, Larks Lake, Good Hart, Middle Village, Five Mile Creek, Cecil Bay, Big Stone Bay. MACKINAC CO.–Bois Blanc Island, Mackinac Island, McKays Creek, Bush Bay, Prentiss Bay, Gros Cap, Ozark, Caffey Corner. PRESQUE ISLE CO.–Rainy River Falls, Clinton Lake.

Our most common member of the genus, best recognized by drooping, tapered branches and broadly short-pointed leaves.

3. **Anomodon minor** (Hedw.) Fürnr.—Rather coarse plants in loose, dark- or glaucous-green to yellowish- or brownish-green mats. Primary stems and stolons with small leaves with wide-spreading or squarrose tips; secondary stems and branches erect-ascending. Leaves erect or imbricate and not or only slightly contorted when dry, somewhat spreading when moist, broadly oblong from an ovate, broadly decurrent base, rounded or rounded-obtuse at the apex; margins plane, papillose-crenulate; costa ending well below the apex. Setae 6-12 mm. long, pale-yellow; capsules 1.5-2.3 mm. long, oblong-cylindric or cylindric, brown, smooth or ± furrowed when dry; annulus revoluble; operculum (0.3)0.6-0.9 mm. long, obliquely rostrate; stomata none; peristome teeth white or pale and yellowish to brownish, smooth at the base; endostome adhering to the teeth, consisting of a very low, scarcely discernible membrane and rudimentary segments. Spores brownish, finely papillose or smooth, 11-15 $\mu$. Calyptrae smooth.—n = 11.

Breen, Mosses of Florida, Pl. 97 (figs. 5-6). Conard, How to Know the Mosses, (ed. 2) fig. 185. Grout, Mosses with Hand-lens and Microscope, Pl. 59. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 34, (ed. 2) Pl. 38. Welch, Mosses of Indiana, fig. 233.—**Fig. 667-668.**

On trunks or bases of trees, sometimes on logs, stumps, or rocks; probably preferring calcareous habitats. Eastern Asia; Mexico; western Texas and Arizona; widespread in eastern North America.

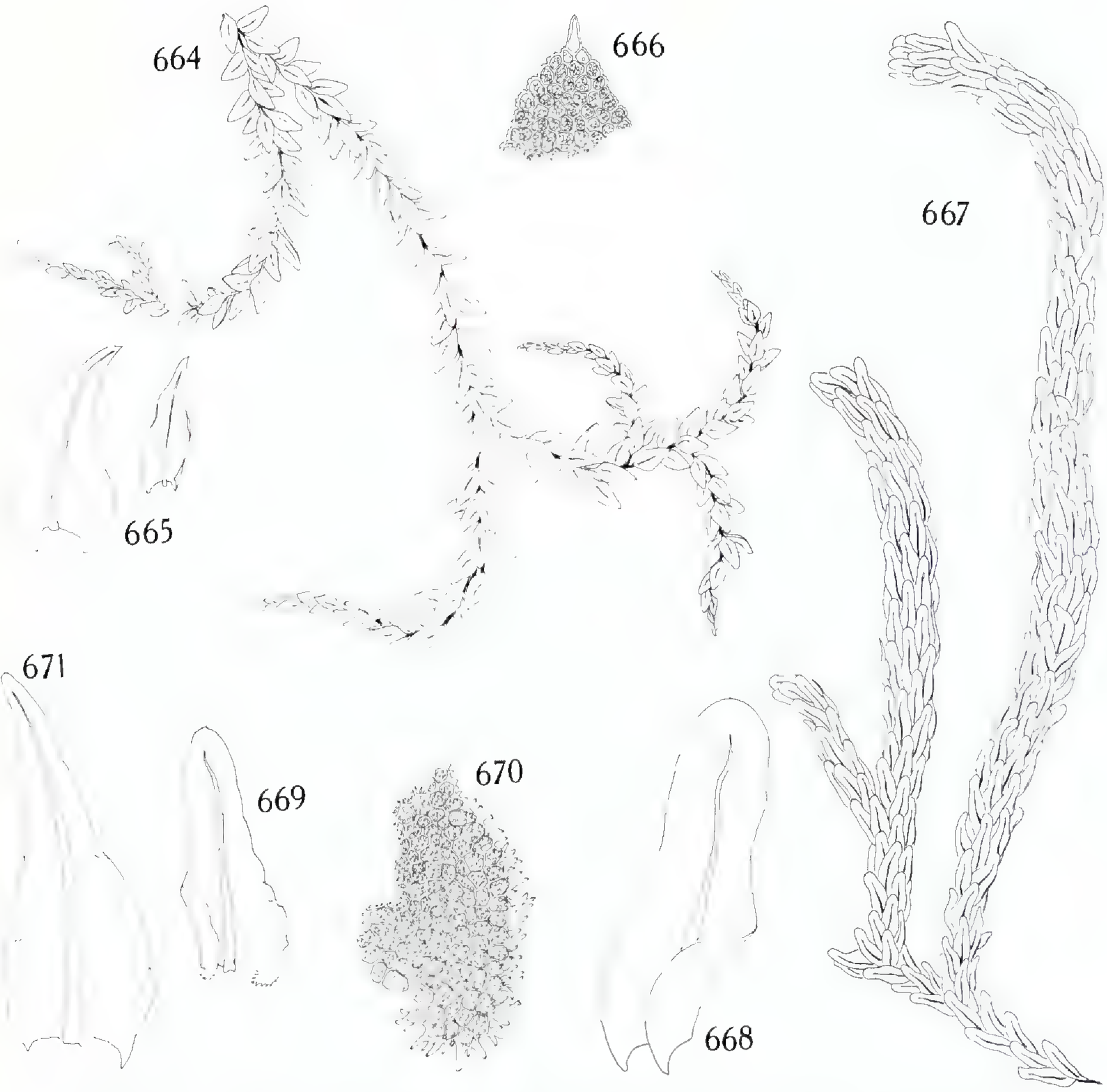
CHEBOYGAN CO.—Fontinalis Run, Colonial Point, Mud Lake. EMMET CO.—Burt Lake, Maple River, Carp Lake, Cross Village, Five Mile Creek, Cecil Bay, Wilderness State Park. MACKINAC CO.—Bois Blanc Island.

Most likely to be confused with *A. rugelii,* this species is distinguished from it (and all the other species) by broadly lingulate, rounded-obtuse leaf points which are erect and scarcely incurved or contorted when dry. As Grout said, "Any *Anomodon* with any of the leaves acute, apiculate or serrulate at the apex is pretty surely not this species."

4. **Anomodon rugelii** (C. M.) Keissl.—Rather coarse plants in dark-green, yellowish or brownish, dense mats; primary stems often producing stolons with small, wide-spreading or squarrose leaves; secondary stems and branches erect-ascending. Leaves incurved-contorted when dry, erect-spreading when moist, broadly oblong-ligulate and scarcely tapered from an ovate, broadly auricled, non-decurrent base, rounded at the apex; margins plane, papillose-crenulate all around, often irregularly and sparsely denticulate at the apex; costa ending well below the apex. Perichaetial leaves erect, pale-green, ligulate-pointed and obtuse from a broader, sheathing base, strongly costate, cells green and papillose to below the shoulders, margins crenulate-papillose above, crenate-serrulate toward the insertion. Setae 8-12 mm. long, yellow, becoming red-yellow with age; capsules 2-2.5 mm. long, cylindric, dark-brown, smooth or irregularly furrowed when dry; annulus of 2(3) rows of cells, remaining attached to the operculum after dehiscence; operculum 0.7-0.8 mm. long, obliquely rostrate; stomata at extreme base of the urn; peristome teeth white, smooth at base; endostome segments adhering to the teeth, irregular and unequal or rudimentary (sometimes 1/3 as long as the teeth), cilia none. Spores brownish, finely papillose or nearly smooth, 11-16 $\mu$. Calyptrae smooth.—n = 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 186d. Grout, Mosses with Hand-lens and Microscope, fig. 135a-c (as *A. apiculatus*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 34 (as *A. apiculatus*), (ed. 2) Pl. 38.—**Fig. 669-670.**

On the bark of trees and stumps (often at the base) and sometimes on rocks; probably preferring calcareous habitats. Europe; Asia; Maine to Ontario and Michigan, south to Tennessee and Georgia.




*Anomodon attenuatus.* 664. Habit. 665. Branch leaves. 666. Cells at tip of branch leaf.
*Anomodon minor.* 667. Habit. 668. Leaf.
*Anomodon rugelii.* 669. Leaf. 670. Cells at basal auricles.
*Anomodon viticulosus.* 671. Leaf.

CHEBOYGAN CO.–Gorge of Carp Creek, Fontinalis Run. EMMET CO.–Pellston, Five Mile Creek, Levering, Larks Lake, Carp Lake, Big Stone Bay. MACKINAC CO.–Prentiss Bay, Gros Cap.

Similar to *A. minor* but with leaves incurved-contorted when dry, often irregularly denticulate at the apex and somewhat fimbriate-auriculate at the base. *A. viticulosus* has longer, more tapered leaf points.

5. **Anomodon viticulosus** (Hedw.) Hook. & Tayl.–Plants coarse and robust, in dark-green, yellowish, or brownish, usually dense mats. Primary stems and stolons with small, wide-spreading to squarrose leaves; secondary stems and branches generally ascending. Leaves erect and ± incurved-contorted when dry, erect-spreading when moist, long, lance-ligulate from an ovate, broadly decurrent base, tapered to a rather narrow, obtuse apex; margins plane, crenulate-papillose; costa ending somewhat below the apex. Setae 8-16 mm. long, yellow, becoming ± red-yellow with age; capsules 2.4-3 mm. long, cylindric, dark-brown, smooth or occasionally indistinctly furrowed when dry and empty; annulus of 3 rows of cells, deciduous in fragments; operculum

0.8-1 mm. long, obliquely rostrate; stomata none; peristome teeth pale-yellow or white, smooth at the base; endostome segments 1/3-2/3 as long as the teeth, often unequal, linear, keeled, not perforate, cilia none or single, stout stubs. Spores brown, finely papillose, 11-19 $\mu$. Calyptrae smooth.—n = 10+1, 11.

Darlington, Mosses of Michigan, fig. 110. Grout, Mosses with Hand-lens and Microscope, fig. 136.—**Fig. 671.**

On limestone cliffs, less commonly on trunks, bases, and exposed roots of trees, in moist, shady places. Europe, Asia, northern Africa; Michigan to Nova Scotia, south to Arkansas and Tennessee.

EMMET CO.—Levering. MACKINAC CO.—Mackinac Island, McKays Creek. (Common in the sinkholes of Alpena County.)

Larger than *A. rugelii,* with long-tapered, ligulate-lanceolate leaf points.

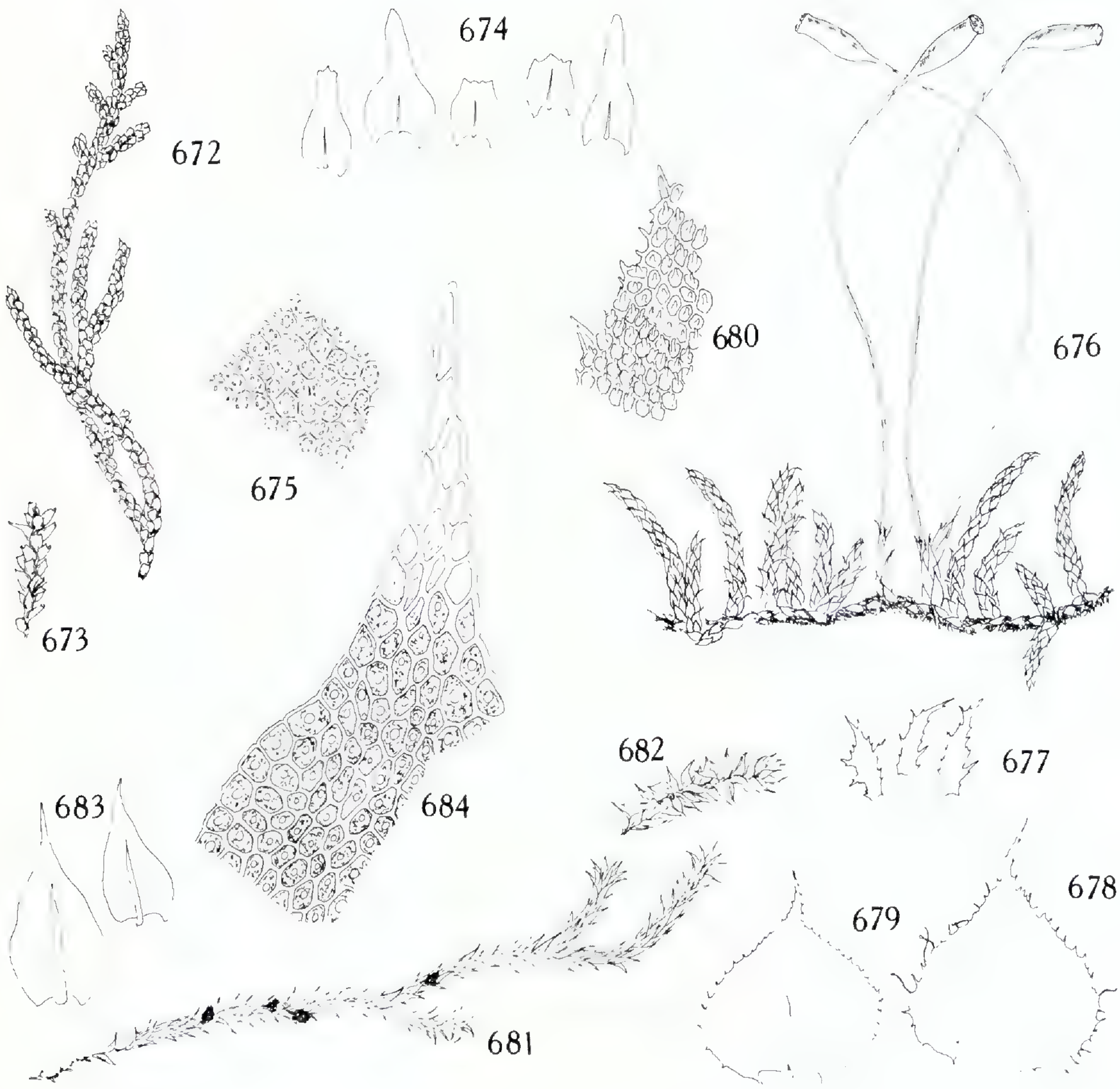
Not yet found in this part of Michigan, though widespread in much of eastern North America, is **Haplohymenium triste** (Ces. *ex* De Not.) Sull. (fig. 672-675). Typically on trunks of trees, the plants are *Anomodon*-like in appearance and structure. They are slender, irregularly branched, with stem and branch leaves similar, imbricate when dry, wide-spreading when moist, abruptly narrowed from a broad, ovate base to a lingulate or lanceolate point which is usually broken off.

## 7. **Thelia** Sull.

Plants of medium size, in dense, rigid, dull, green, yellow-green, yellow-brown, grayish, or bluish mats. Stems elongate and creeping or sometimes more crowded and ascending, usually radiculose, sometimes densely so, irregularly branched or more often regularly 1-pinnate; branches ascending, short and blunt, slender and terete or stout and julaceous; paraphyllia very few to fairly abundant (at least on the stems), polymorphous, laciniate or ciliate at the margins. Stem and branch leaves similar or somewhat differentiated. Branch leaves imbricate wet or dry, very concave, deltoid-ovate, abruptly short- to long-apiculate, ± decurrent; margins erect, dentate or irregularly spinose-dentate above and ± ciliate below; costa single, slender, ending at or above the leaf middle (or very rarely and atypically short and double); cells firm-walled, rhombic, coarsely unipapillose on the lumina at back nearly to the insertion (the papillae simple or elaborately branched), somewhat elongate near the costa at base, subquadrate at the basal angles. Phyllodioicous; the male plants minute, resting on leaves or tomentum of female plants; perichaetial leaves pale-yellow, enlarged, erect and sheathing, gradually subulate from an oblong base (with long, flexuose cilia with spreading to recurved teeth at their margins), with costa weak or obsolete and cells elongate, those at the apex ± papillose. Setae rather short to elongate, yellow to red-yellow, smooth, flexuose; capsules erect and symmetric, cylindric to ovoid-cylindric, yellow or brown, smooth or somewhat wrinkled-striate when dry and empty; annulus none or poorly developed and persistent or sometimes fragmenting; operculum long, conic-subulate, slightly oblique; stomata at extreme base of urn; peristome teeth inserted at or somewhat below the mouth on a very low membrane, white or whitish-yellow, long, narrowly lanceolate, smooth near the base, densely papillose above, not bordered or trabeculate; endostome pale and papillose, consisting of a rather low basal membrane, short, irregular or rudimentary segments, and no cilia. Calyptrae cucullate, smooth, naked.—The name refers to the strong papillae on the leaf cells.

**Thelia hirtella** (Hedw.) Sull.–Plants green, yellow-brown, or grayish-yellow. Stems creeping, densely radiculose, closely 1-pinnate; branches slender and terete or sometimes stouter and julaceous; paraphyllia fairly numerous (especially on the stems). Stem leaves about 1-1.3 mm. long, strongly ciliate at the margins. Branch leaves about 1 mm. long, usually not particularly crowded, rather abruptly narrowed to a short to fairly long apiculus or piliform acumen which is usually flexuose or spreading when dry; margins irregularly dentate all around and usually ± spinose-ciliate, especially toward the base; costa single and ½-¾ the leaf length (or occasionally short and double); upper cells about 8 $\mu$ wide, about 1.5:1, each bearing a simple, high, curved papilla at back (rarely an exceptional papilla bluntly bifid). Setae 5-12 mm. long; capsules 1.5-2.5 mm. long; annulus none or occasionally slightly differentiated in about 2 rows and fragmenting. Spores 12-18 $\mu$, nearly smooth to finely roughened.

Breen, Mosses of Florida, Pl. 98 (figs. 1-6). Conard, How to Know the Mosses, (ed. 2) fig. 179. Grout, Mosses with Hand-lens and Microscope, fig. 139, Moss Flora of North America 3: Pl. 49B. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 34, (ed. 2) Pl. 38. Welch, Mosses of Indiana, fig. 230.–**Fig. 676-680.**




*Haplohymenium triste*. 672. Habit, dry. 673. Portion of plant, moist. 674. Leaves. 675. Upper cells of leaf.

*Thelia hirtella*. 676. Habit. 677. Paraphyllia. 678. Stem leaf. 679. Branch leaf. 680. Upper cells of branch leaf.

*Lindbergia brachyptera*. 681. Habit, dry. 682. Portion of plant, moist. 683. Leaves. 684. Cells at leaf tip.

Usually on the bark of hardwoods (occasionally–elsewhere–on junipers), especially on the bases of trees or on their exposed roots, sometimes on decayed logs or stumps, rarely on soil or rocks, in rather dry, open woods. Widespread in eastern North America; northeastern Mexico.

CHEBOYGAN CO.–Fontinalis Run.

The high, curved, conic papillae at the back of the leaves scarcely compare in shock value with the elaborately branched papillae of *T. asprella* Sull. and *T. lescurii* Sull. The dwarf male plants are not only very small but also few and hard to find.

*Thelia asprella* has been found in southern Michigan. It has much the same range from the Great Lakes southward as *Thelia lescurii* and has been greatly confused with it. **Thelia asprella** nearly always grows on bark at base of trees. It has creeping, radiculose, pinnately branched stems; its branches are slender, terete, and simple; its leaves, usually not particularly crowded, are ciliate-papillose above, long-ciliate below, acute or obtuse, and long-apiculate to piliform-apiculate. **Thelia lescurii**, by contrast, grows on sandy soil. Its stems are crowded and ascending, not or slightly radiculose, irregularly branched; its branches short and julaceous, often forked; its leaves crowded, not or somewhat ciliate-papillose at the margins, obtuse, shortly apiculate.

## 8. **Lindbergia** Kindb.

Rather slender plants in loose, dull, rigid, dark-green, yellowish, or brownish mats. Stems creeping, freely and mostly irregularly branched; paraphyllia few or lacking. Leaves crowded, appressed when dry, wide-spreading to squarrose when moist, somewhat concave, ovate or ovate-lanceolate, slenderly short-acuminate, ± decurrent, not plicate; margins erect, entire or rarely indistinctly toothed near the apex; costa fairly strong, ending well below the leaf apex; cells rounded-hexagonal or rhombic, with firm or thickened walls, smooth or unipapillose over the lumina, smaller and quadrate or oblate-rectangular in many rows at the basal margins. Autoicous; perichaetial leaves enlarged, pale, erect, lanceolate- to subulate-acuminate from a sheathing base, entire or finely toothed, with a short costa and elongate, smooth cells. Setae elongate; capsules erect and symmetric, sometimes weakly curved, oblong-cylindric, smaller at the mouth, brown; annulus sometimes differentiated; operculum conic, blunt; peristome inserted well below the mouth, the teeth lanceolate, blunt, fused at base, pale or yellow, ± papillose, not striolate, with low trabeculae at back below; endostome a low, finely papillose membrane. Calyptrae cucullate, smooth, naked.–Named for the great Scandinavian bryologist, Sextus Otto Lindberg.

**Lindbergia brachyptera** (Mitt.) Kindb.–Paraphyllia none; brood-branchlets common in axillary clusters. Leaves 0.9-1.4 mm. long, ovate or ovate-lanceolate, gradually or abruptly narrowed to a pale or yellowish acumen; margins entire or faintly serrulate above; costa 1/2-2/3 the leaf length; upper median cells thick-walled, rounded to rhombic (8-10 $\mu$ wide and 1-2:1, bluntly unipapillose on both surfaces, rounded-quadrate and often oblate in many oblique rows at the basal margins; apical cells oblong, smooth. Setae 6-8 mm. long, yellow-brown, smooth; capsules 1-1.5 mm. long, yellow-brown, smooth; annulus none; operculum convex-conic; stomata in the neck; peristome teeth yellow, densely papillose; endostome yellowish. Spores 18-23 $\mu$, very minutely roughened.

Darlington, Mosses of Michigan, fig. 105. Grout, Moss Flora of North America 3: Pl. 51A (as *L. austinii*). Welch, Mosses of Indiana, fig. 228.–**Fig. 681-684.**

On trunks of trees, particularly on roadside elms and maples, occasionally on old logs or fence rails, very rarely on rocks. Caucasus and the Himalayas; Japan; widespread in eastern North America; Arizona and western Texas.

CHEBOYGAN CO.–Gorge of Carp Creek, Burt Lake, Riggsville, Black Lake. EMMET CO.–Brutus, Pellston Hills, Larks Lake, between Levering and Cross Village, Cross Village, Sturgeon Bay. PRESQUE ISLE CO.–Hammond Bay.

The plants generally occur as scattered strands. The dark-green leaves, squarrose when moist and tipped with short hair-points are distinctive, as are the dense clusters of short, axillary branchlets and the rounded to rhombic, bluntly unipapillose cells.

## 9. **Haplocladium** (C. M.) C. M.

Plants rather small to medium-sized, in loose, dull, yellowish, brownish, or light-green mats. Stems prostrate, subpinnately branched; branches spreading or ascending; paraphyllia few to abundant, especially on the stems, polymorphous. Stem and branch leaves somewhat differentiated, erect to somewhat incurved and sometimes subsecund when dry, erect-spreading when moist: Stem leaves often biplicate, ovate, short- to long-acuminate; margins plane or, more often, ± revolute below; costa extending well into the acumen to excurrent, often flexuose above; cells irregularly rhombic, firm-walled, bearing a single, low papilla at back. Branch leaves smaller and narrower, ending in a unipapillose cell. Autoicous; perichaetial leaves pale, erect, elongate, narrowly long-acuminate from a lanceolate base. Setae elongate, smooth, becoming reddish; capsules strongly inclined to horizontal, curved and constricted below the mouth when dry, oblong-cylindric; annulus well developed; operculum conic, acute to short-rostrate; stomata at base of the capsule; peristome teeth lance-subulate, yellow or yellow-brown and cross-striolate below, pale and papillose above, bordered, trabeculate; endostome pale-yellowish, finely papillose, with a high basal membrane, keeled and sometimes narrowly perforate segments, and well-developed, nodose or appendiculate cilia in groups of 2-4. Calyptrae cucullate, smooth, naked.–The name refers to the branching system, once-pinnate as compared with the bipinnate or even tripinnate systems of many species of *Thuidium.*

**Haplocladium microphyllum** (Hedw.) Broth.–Plants of medium size. Stems and branches loosely foliate; paraphyllia few to fairly abundant. Stem leaves loosely erect, frequently flexuose or subsecund at the tips when dry, about 0.55-1.3 mm. long, ovate or ovate-lanceolate, gradually or abruptly long-acuminate, biplicate at base; margins revolute below, sinuate-serrulate above; costa subpercurrent. Branch leaves erect and often ± incurved when dry, ovate-lanceolate, acuminate. Setae often flexuose, 15-30 mm. long; capsules 1.5-2 mm. long; operculum apiculate to stoutly short-rostrate; cilia of endostome appendiculate, in groups of 3-4. Spores 9-11 $\mu$, nearly smooth.–n = 10, 10+1, 11.

Grout, Mosses with Hand-lens and Microscope. Pl. 55 (as *Thuidium*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 35, (ed. 2) Pl. 39. Welch, Mosses of Indiana, fig. 223 (as *Thuidium*).–**Fig. 685-690.**

On soil, humus, and other substrata in the shade, often in rather dry, disturbed, brushy habitats. Europe and Asia; Mexico, Central and South America, West Indies; British Columbia to Nova Scotia, south to Florida and Texas; Arizona.

CHEBOYGAN CO.–Fontinalis Run, Colonial Point, Smiths Bog, Douglas Lake. EMMET CO.–Larks Lake, Middle Village, Five Mile Creek.

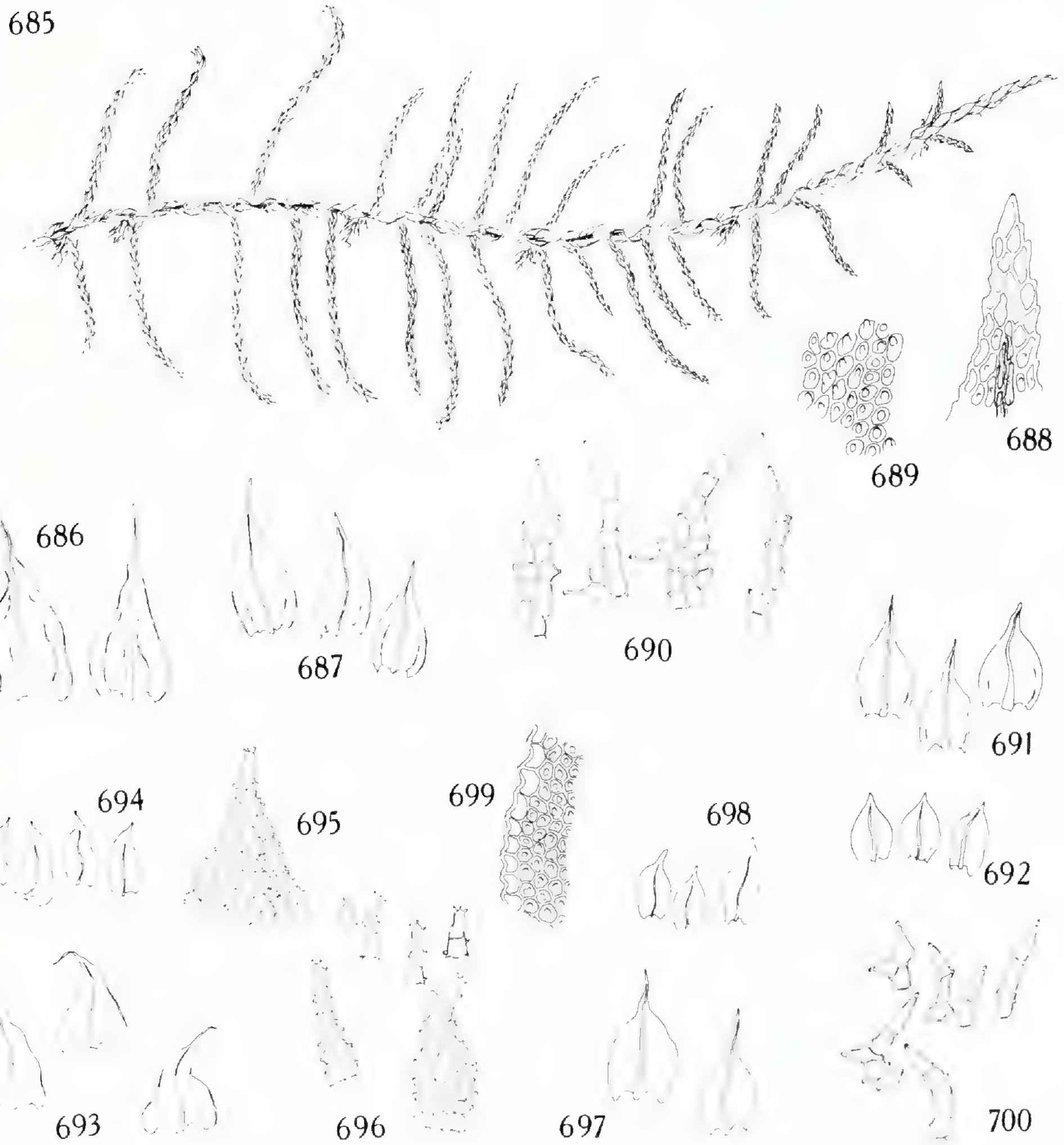
**Haplocladium virginianum** (Brid.) Lindb. (fig. 691-692), to be expected in our area, looks rather more like a *Thuidium* and can be confused with *T. minutulum* (which has pluripapillose leaf cells). As compared with *Haplocladium microphyllum,* it has rather rigid, julaceous branches with crowded leaves, more numerous paraphyllia, and stem leaves not plicate, broadly short-acuminate, with margins plane or nearly so and irregularly dentate above.

## 10. **Thuidium** BSG

Small to fairly robust plants in dull, green, yellowish, or brownish, loose, often rigid mats. Stems creeping to curved-ascending, regularly 1-3-pinnate and often frondose; paraphyllia abundant, papillose, often polymorphous. Stem and branch leaves differentiated: Stem leaves ovate or subcordate, acuminate, narrowed to the base and somewhat decurrent, generally ± biplicate; margins ± revolute below, not or somewhat toothed above; costa ending below the apex or rarely excurrent; cells mostly uniform, rounded- to oblong-hexagonal, firm- or thick-walled, minutely pluripapillose on 1 or both surfaces or coarsely unipapillose at back. Leaves of primary branches often rather similar to stem leaves, those of secondary and tertiary branches much smaller, concave, with erect margins, mostly ovate, acute or sometimes obtuse or rounded, usually ending in a truncate cell with more than 1 papilla and costa shorter and weaker. Perichaetial leaves ± elongate, erect, pale, lanceolate or ovate-lanceolate, long-acuminate, sometimes ciliate at the margins, the costa ending in the acumen or subpercurrent, the cells elongate, smooth or somewhat papillose. Setae elongate, smooth or papillose; capsules mostly inclined to horizontal and ± curved, brown, oblong-cylindric, smooth; annulus of 2-3(4) irregular rows of cells, often tardily deciduous; operculum conic or convex-conic, often obliquely rostrate; stomata in the neck; peristome teeth yellow or yellow-brown and cross-striolate below, pale and papillose above; endostome pale, yellowish or brownish, finely papillose, consisting of a high basal membrane, keeled and narrowly perforate segments, and ± nodulose cilia in groups of 2-4 (rarely rudimentary or lacking). Calyptrae cucullate, smooth, naked (or rarely sparsely hairy).—Named because of a resemblance in feathery, frondose branching (of some of the species) to *Thuja,* the arbor vitae or northern white cedar. Commonly called the FERN MOSSES.

1. Relatively robust, dioicous plants; leaf cells stoutly unipapillose
   2. Stems suberect, 1-pinnate — 3. *T. abietinum*
   2. Stems spreading or curved-ascending, 2-3-pinnate
      3. Stem leaves incurved at base, wide-spreading or recurved at the tips, with margins plane or nearly so and costa almost filling the acumen; paraphyllia with papillae at the upper ends of the cells; operculum high-conic — 4. *T. recognitum*
      3. Stem leaves erect, with margins revolute and costa ending below the apex and not filling the acumen; paraphyllia with papillae not restricted to cell ends; operculum rostrate
         4. Stem leaves not ending in a capillary point; inner perichaetial leaves ciliate — 5. *T. delicatulum*
         4. Stem leaves ending in a capillary point formed by 2-7 or more uniseriate cells; perichaetial leaves not ciliate (or only rarely ± ciliate) — 5a. *T. delicatulum* var. *radicans*
1. Small, autoicous plants; leaf cells minutely pluripapillose
   5. Plants 1-pinnate; branches terete when dry; leaves imbricate when dry, erect-spreading when moist; leaf cells papillose at back — 2. *T. scitum*
   5. Plants 1- or more commonly 2-pinnate; branches not terete; leaves incurved-catenulate when dry, wide-spreading when moist; leaf cells papillose on both surfaces — 1. *T. minutulum*

1. **Thuidium minutulum** (Hedw.) BSG—Small, dark-green plants. Stems 2-4 cm. long, creeping, 1-2-pinnate; paraphyllia numerous on stems and primary branches, few on secondary branches, simple, 3(or rarely as many as 6) cells long. Stem leaves erect




*Haplocladium microphyllum*. 685. Habit. 686. Stem leaves. 687. Branch leaves. 688. Cells at tip of branch leaf. 689. Upper cells of branch leaf. 690. Paraphyllia.

*Haplocladium virginianum*. 691. Stem leaves. 692. Branch leaves.

*Thuidium minutulum*. 693. Stem leaves. 694. Branch leaves. 695. Cells at apex of branch leaf. 696. Paraphyllia.

*Thuidium scitum*. 697. Stem leaves. 698. Branch leaves. 699. Upper cells at margin of leaf. 700. Paraphyllia.

or somewhat incurved when dry, wide-spreading or squarrose when moist, 0.3-0.55 mm. long, usually gradually acuminate from an oblong-ovate, obscurely biplicate base; margins papillose-crenulate, revolute below or occasionally well up the acumen; upper cells mostly 8-12 $\mu$ long, irregularly oblong or rounded-hexagonal, firm-walled, pluripapillose on both surfaces; costa 2/3-4/5 the leaf length, sometimes vanishing near the apex. Leaves of primary branches incurved-catenulate when dry, wide-spreading when moist, ovate, short-acuminate with 1-2 cells often projecting at the apex as a hyaline, pluripapillose apiculus; costa 2/3-4/5 the leaf length. Leaves of secondary branches about 0.2-0.25 mm. long, ovate or oblong-ovate, broadly acute or sometimes blunt, particularly at the ends of branches; costa 1/2-7/10 the leaf length; cells 6-8 $\mu$, the terminal cells pluripapillose, not projecting. Autoicous; perichaetial

leaves up to 1.4 mm. long, entire or somewhat irregular at the margins above. Setae 7-21 mm. long, red, smooth; capsules 0.7-1.5 mm. long, oblong or oblong-ovoid, curved and asymmetric, inclined to horizontal; operculum long-rostrate, usually about 1 mm. long; cilia of endostome nodulose, in 1's-3's. Spores 9-12 $\mu$, smooth or indistinctly roughened.—n = 9+2, 11.

Breen, Mosses of Florida, Pl. 101 (figs. 5-8). Grout, Mosses with Hand-lens and Microscope, fig. 122a, 123a, 128, Moss Flora of North America 3: Pl. 37 upper left. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 35, (ed. 2) Pl. 39. Welch, Mosses of Indiana, fig. 221.—**Fig. 693-696.**

On decayed wood or on rocks and soil, often on exposed roots or bases of trees in moist woods. Europe, Azores, Bermuda; widespread in eastern North America; Middle and South America; West Indies.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Burt Lake, Gorge of Carp Creek, Carp Creek, Black Lake. PRESQUE ISLE CO.—Clinton Lake.

The distinguishing features of *T. minutulum* include small size, 1-2-pinnate branching, leaves incurved when dry, and pluripapillose leaf cells.

A similar but much smaller moss not yet found in Michigan but to be expected on moist, shaded limestone rocks and pebbles especially in stream valleys is **T. pygmaeum** BSG, which is best determined by papillae on stems and branches. *Haplocladium virginianum* (Brid.) Broth., not yet found in our range, can be mistaken for *Thuidium minutulum.* In case of doubt, the number of papillae on leaf cells is diagnostic, single in *Haplocladium,* pluripapillose in *Thuidium minutulum.* (The branch leaves ending in more than one point is a generic character of *Thuidium* which should also be helpful.)

2. **Thuidium scitum** (P.-Beauv.) Aust.—Rather small, rigid, dark-green, yellow-brown, or brown plants. Stems creeping, 1-pinnate; branches short, terete; paraphyllia abundant on stems and branches, linear to ovate, often branched. Stem leaves erect when dry, erect-spreading when moist, broadly ovate, gradually or abruptly narrowed to a slender or filiform acumen, concave, not or moderately biplicate; margins reflexed or loosely revolute below; costa vanishing in the base of the acumen; upper cells irregularly rounded-hexagonal, firm-walled, about 6 $\mu$ wide, pluripapillose at back; cells near costa at base oblong. Branch leaves appressed when dry, wide-spreading when moist, small, ovate, acute. Autoicous. Setae 9-19 mm. long, yellow or red-yellow, smooth, flexuose; capsules 1.2-2 mm. long, suberect to horizontal, oblong-cylindric, asymmetric, constricted below the mouth and at the short neck when dry; operculum stoutly and obliquely rostrate; cilia of endostome in 2's and 3's. Spores 10-13 $\mu$, finely papillose.—n = 11.

Conard, How to Know the Mosses, (ed. 2) fig. 192e. Grout, Mosses with Hand-lens and Microscope, figs. 126a, 133b, c, Moss Flora of North America 3: Pl. 44B. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 35 & (ed. 2) Pl. 39 (as *Rauia*).—**Fig. 698-700.**

On bark, especially at the base of trees, occasionally on logs or stumps or rocks. Widespread in eastern North America, New Brunswick to Michigan, south to Missouri and North Carolina.

CHEBOYGAN CO.—Colonial Point. EMMET CO.—Pellston Hills, Carp Lake, Cross Village, Cecil Bay, Wilderness State Park. MACKINAC CO.—Gros Cap. PRESQUE ISLE CO.—Hoeft State Park.

The small, rigid, once-pinnate plants with branch leaves appressed when dry are suggestive of *T. abietinum.* Size alone will distinguish them, but a more basic

difference is the pluripapillose leaf cells of *T. scitum* contrasting with the unipapillose cells of *T. abietinum*. *Thuidium minutulum* is 1-2-pinnate, with leaves incurved-catenulate when dry.

3. **Thuidium abietinum** (Hedw.) BSG—Relatively robust, rigid, dark-green, yellowish, or dark-brown plants. Stems up to 12 cm. high, erect-ascending, 1-pinnate; branches short, ± unequal, terete, tapered; paraphyllia abundant on stem and branches, linear and simple or branched or lanceolate. Stem leaves erect when dry, erect-spreading when moist, 1.2-1.8 mm. long, ovate, broadly acuminate, plicate, orange-yellow at the insertion; margins irregularly revolute below the middle and sometimes above it as well; costa 3/4 or more the leaf length; cells rhombic or irregularly oblong-hexagonal, thick-walled, stoutly unipapillose at back (the papillae occasionally bluntly forked). Branch leaves erect when dry, erect-spreading when moist, 0.6-0.7 mm. long, ovate, acute; cells rounded-quadrate or rhombic, about 7-11 $\mu$, the terminal cell with 2 or more papillae. Dioicous; perichaetial leaves up to about 4 mm. long, serrulate above. Setae about 25 mm. long, reddish, flexuose; capsules 2-3 mm. long, cylindric, strongly curved, inclined; operculum obliquely very short-rostrate; cilia of endostome single and paired; Spores 9-11 $\mu$, very finely roughened.—n = 11.

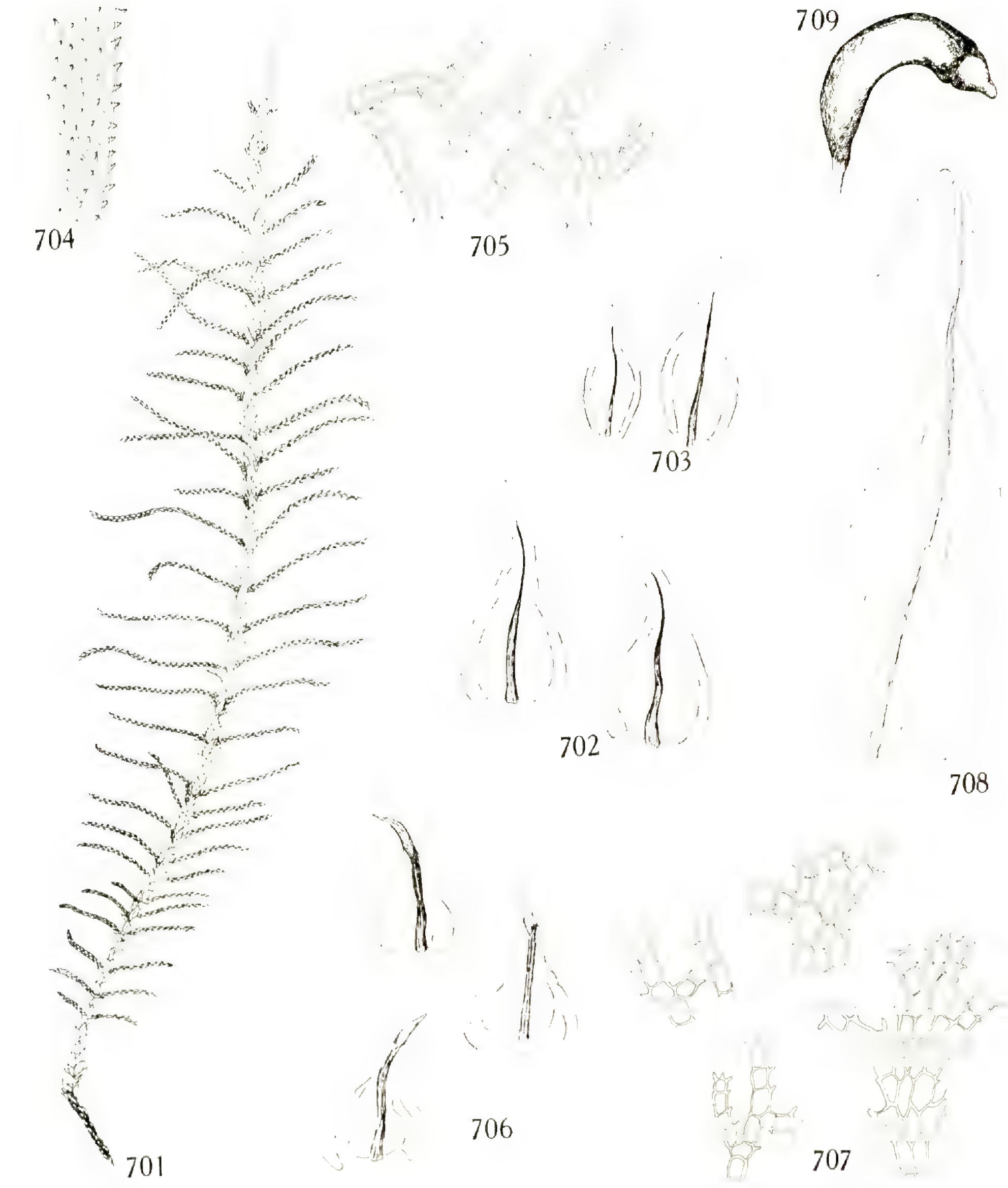
Conard, How to Know the Mosses, (ed. 2) fig. 192a-d. Grout, Mosses with Hand-lens and Microscope, figs. 126b, 133d, Moss Flora of North America 3: Pl. 37 lower left. Welch, Mosses of Indiana, fig. 220.—**Fig. 701-705.**

On rock and sandy, gravelly, or turfy soil in dry, usually calcareous habitats, frequently on old dunes or dry hillsides, in open, coniferous stands, on ledges, at bases of cliffs, or among talus rocks. Circumpolar; Greenland to Alaska and south to Arizona, Colorado, Iowa, Indiana, and Virginia.

CHEBOYGAN CO.—Biological Station Campus, Pine Point and Fairy Island (Douglas Lake), Mill Creek, EMMET CO.—Cross Village, Cecil Bay, Big Stone Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island, Bush Bay, Prentiss Bay, St. Martins Point, McKays Creek. PRESQUE ISLE CO.—Mast Point, south of Hoeft State Park.

The large, wiry, loosely once-pinnate aspect of the plants is unmistakable in the field, as is the xerophytic habitat in exposed places, such as dune sands.

4. **Thuidium recognitum** (Hedw.) Lindb.—Rather robust plants in rigid, light- or yellow-green to yellow-brown mats. Stems 4-9 cm. long, spreading or arched-ascending, bipinnate and frondose; paraphyllia very abundant (especially on stems and primary branches), mostly filiform and branched, also lanceolate, the cells strongly papillose (mostly at or near their upper ends), the terminal cell usually with 2-3 large, divergent papillae. Stem leaves ± incurved at base with wide-spreading tips when dry, spreading with reflexed tips when moist, about 1 mm. long, broadly ovate, abruptly acuminate, distinctly plicate; margins papillose-serrulate, more strongly serrulate in the acumen, plane (at least when the leaf is removed from the stem) or rarely ± revolute below; costa broadened above, nearly filling the acumen, and disappearing near the apex; upper cells 8-10 $\mu$ wide (up to 24 $\mu$ long), rhombic or oblong-rhombic, thick-walled, stoutly unipapillose. Leaves of primary branches smaller, with a shorter costa. Leaves of secondary branches about 0.2 mm. long, erect-spreading wet or dry, ovate, acute; costa 1/3-2/3 the leaf length; upper cells rhombic, 8-10 × 8-12 $\mu$, incrassate, stoutly unipapillose, the papillae simple, curved-spinose (usually 8-12 $\mu$ high), the terminal cell truncate, pluripapillose. Dioicous; perichaetial leaves up to 4.2 mm. long, with margins denticulate (and sometimes dentate or notched near the base of the acumen). Setae 20-42 mm. long, reddish, smooth; capsules 2-3.5 mm. long, cylindric, curved and




*Thuidium abietinum*. 701. Habit. 702. Stem leaves. 703. Branch leaves. 704. Upper cells of leaf. 705. Paraphyllia.

*Thuidium recognitum*. 706. Stem leaves. 707. Paraphyllia. 708. Perichaetial leaf. 709. Capsule.

horizontal; operculum high-conic or bluntly short-rostrate, about 0.7-1 mm. long; cilia of endostome nodulose, in 2's or 3's. Spores 11-16 $\mu$, smooth or nearly so.—n = 11.

Conard, How to Know the Mosses, (ed. 2) fig. 194a-b. Grout, Mosses with Hand-lens and Microscope, fig. 127. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 36, (ed. 2) Pl. 40. Welch, Mosses of Indiana, fig. 219.—**Fig. 706-709.**

On soil, humus or rocks and sometimes also on logs, bases of trees, or exposed roots, in wet or dry woods, open swamps, or meadows. Circumpolar; Alaska to Newfoundland, south to Georgia, Arkansas, and Oklahoma.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Fairy Island (Douglas Lake), Wolffs Bog, Mud Lake, Grass Bay. EMMET CO.–Levering, Galloway Bog, Pleasantview Swamp, Stutsmanville, Cross Village, Cecil Bay, Wilderness State Park, Conway Bog. MACKINAC CO.–Mackinac Island, St. Martins Creek, McKays Creek, Prentiss Bay, Hog Island Point, Epoufette, Ozark, Caffey Corner, Hendricks. PRESQUE ISLE CO.–Presque Isle Lighthouse, Evergreen Beach, Hammond Bay, Mast Point, Rainy River Falls, Rainy Lake, Clinton Lake.

See *T. delicatulum,* below, for means of distinguishing this common species, so commonly misunderstood.

5. **Thuidium delicatulum** (Hedw.) BSG–Rather robust, green or yellowish plants. Stems 3-8 cm. long, spreading or arched-ascending, 2-3-pinnate and ± frondose; paraphyllia very abundant (especially on stems and primary branches), polymorphous but mostly filiform and branched, the papillae not restricted to cell ends, the terminal cell with several rather small papillae. Stem leaves appressed when dry, erect-spreading when moist, 0.6-1.4 mm. long, triangular-ovate, gradually or abruptly narrowed to a broad acumen, plicate; margins papillose-serrulate, revolute from the base to the acumen; costa ending in the acumen well below the apex; upper cells irregularly oblong-hexagonal, 6-10 × 8-12 $\mu$, moderately incrassate, coarsely unipapillose at back. Leaves of primary branches erect-spreading, up to 0.5 mm. long, ovate, acute; costa 1/2-2/3 the leaf length; cells 6-8 × 8-12 $\mu$, rhombic, incrassate, stoutly unipapillose, the papillae 4-12 $\mu$ high, curved and often ± forked, the apical cell truncate, pluripapillose. Leaves of secondary branches similar but smaller. Dioicous; perichaetial leaves up to 5 mm. long, ciliate below, denticulate above. Setae 15-45 mm. long, reddish, smooth; capsules 1.8-4 mm. long, suberect and moderately curved to horizontal and arcuate, cylindric, asymmetric; operculum long-rostrate, 0.75-2 mm. long; cilia of endostome in 2's and 3's. Spores 12-24 $\mu$, smooth.–n = 11.

Conard, How to Know the Mosses, (ed. 2) figs. 193, 194c. Darlington, Mosses of Michigan, fig. 107. Grout, Mosses with Hand-lens and Microscope, figs. 122b, 123b, 128, 133a. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 36, (ed. 2) Pl. 40. Welch, Mosses of Indiana, fig. 217.–**Fig. 710-717.**

On soil or humus, decayed wood, and rocks, often on exposed roots or bases of trees, in moist or wet places. Europe and Asia; Alaska and British Columbia; Arizona; Labrador; widespread in eastern North America; Mexico to South America and the West Indies.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge (Carp Creek), Colonial Point, Vincent Lake, Livingston Bog, Mill Creek, Grass Bay. EMMET CO.–Pellston, Pleasantview Swamp, Wycamp Lake. MACKINAC CO.–Bois Blanc Island, Mackinac Island, Epoufette. PRESQUE ISLE CO.–Lamprey Experiment Station, Evergreen Beach, Clinton Lake.

Often known as the COMMON FERN MOSS.

5a. **Thuidium delicatulum** var. **radicans** (Kindb.) Crum, Steere & Anders.–Intergrading with *T. delicatulum* in most respects but distinguished as follows: Stem leaves 1-1.5 mm. long (averaging 1.2 rather than 0.9 mm.), ending in a slender, hyaline point consisting of 2-8 cells in a single row; perichaetial leaves usually not ciliate (sometimes a few are present, and rarely they are quite well developed); annulus less well developed, of 2-3 rows of cells scarcely differentiated from suboral cells.–n = 11.

Grout, Moss Flora of North America 3: Pl. 44A (as *T. philibertii*),–**Fig. 718-719.**

On soil, humus, and logs in moist or wet woods. Circumpolar; Alaska to British Columbia and Alberta; Quebec, northern Ontario, and Manitoba south to Iowa, Michigan, and Virginia.

*Thuidium delicatulum.* 710. Habit. 711. Stem leaf. 712. Leaves of primary branches. 713. Leaves of secondary branches. 714. Upper cells of branch leaves. 715. Paraphyllia. 716. Perichaetial leaf. 717. Capsule.

CHEBOYGAN CO.–Reeses Bog. EMMET CO.–Levering, Wycamp Lake. MACKINAC CO.–Mackinac Island. PRESQUE ISLE CO.–Kelsey Pond.

Few species as common, widespread, and distinctive as *T. delicatulum* have been so greatly confused. A summary of the distinctive features of *T. delicatulum, T. delicatulum* var. *radicans* (*T. philibertii* Limpr.), and *T. recognitum* follows:

*T. delicatulum* has stem leaves averaging 0.9 mm. long, appressed when dry, erect-spreading when moist, not plicate, rather gradually acuminate, with the costa disappearing in the acumen well below the apex and with margins recurved from the base to the acumen. The paraphyllia bear small papillae along the sides of the cells (rather than at the ends). The perichaetial leaves are abundantly ciliate. The operculum is long-rostrate from a conic base and usually 1-2 mm. long.

The var. *radicans* cannot always be segregated satisfactorily. It has stem leaves longer (averaging about 1.2 mm. long), more finely acuminate, ending in a slender

point consisting of 2-8 hyaline cells in a single row. The perichaetial leaves, usually thought to be eciliate, actually have a few rather short cilia in most instances and sometimes have rather numerous and well-developed ones.

*Thuidium recognitum* has stem leaves which are shortly, broadly, and abruptly acuminate. They are plicate, with margins plane or nearly so (when removed from the stems), and the costa appears to be excurrent but actually spreads out and disappears among elongated cells of the acumen. The tips of the stem leaves spread widely from a concave and incurved base. The perichaetial leaves lack cilia. The paraphyllia are large and usually spinose-papillose at or near the ends of cells. The operculum is not rostrate (or only shortly and bluntly so) and is only about 1 mm. in length or less.

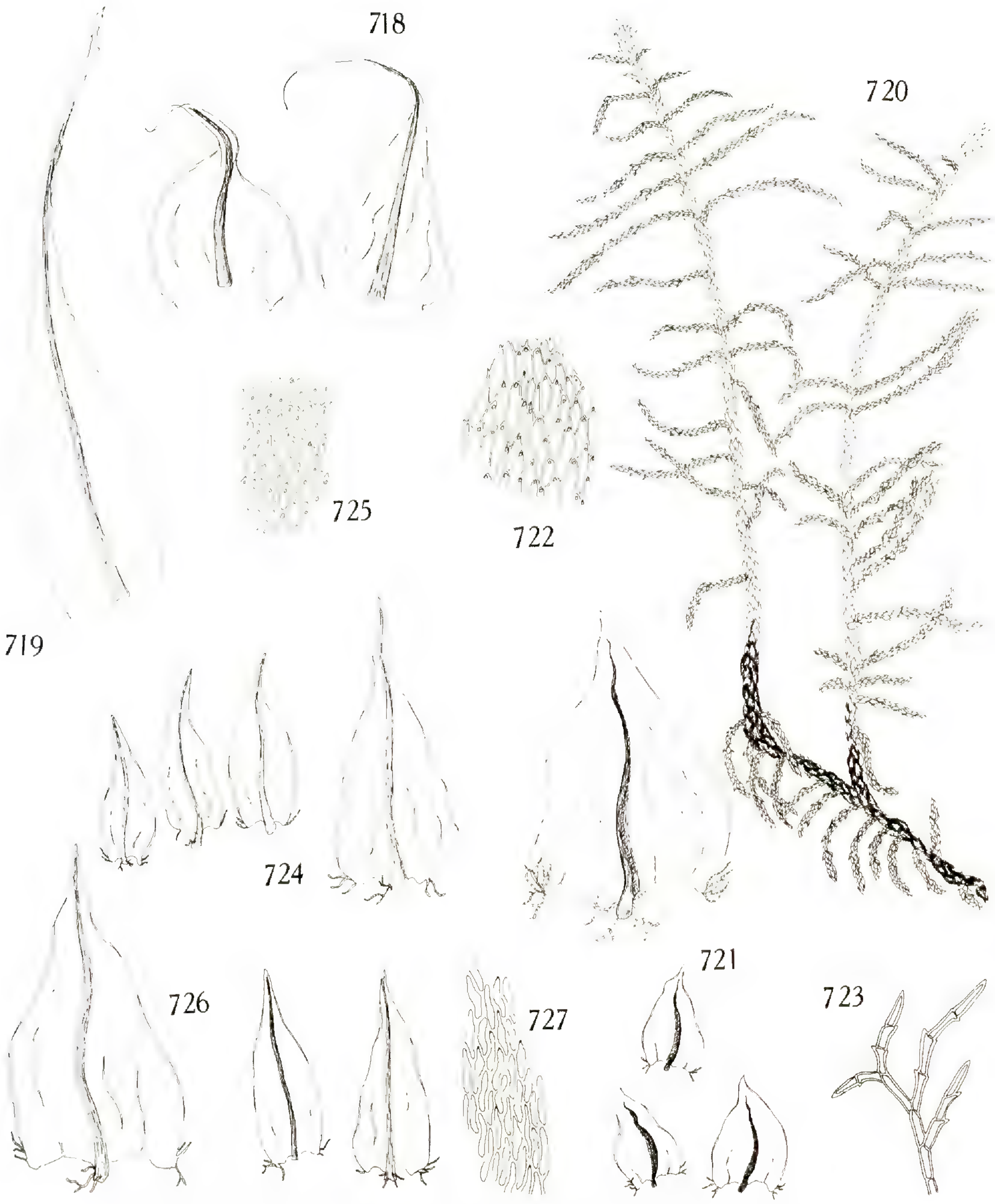
## 11. **Helodium** (Sull.) Warnst., *nom. cons.*

Relatively robust plants in soft tufts or mats, green or yellow-green or sometimes brownish, sometimes slightly shiny. Stems erect or spreading, freely branched and usually regularly pinnate and frondose; paraphyllia abundant on stems and branches, filiform, often branched, smooth, pale (becoming brown with age). Stem and branch leaves similar, ovate-lanceolate, acuminate (and not ending in a truncate cell), ± narrowed at the base, plicate, keeled; margins irregularly revolute nearly to the apex, entire or minutely toothed near the apex; costa strong, disappearing below the apex or sometimes subpercurrent; cells pellucid, thin-walled or incrassate, smooth or unipapillose at back (centrally or near the upper end), oblong-hexagonal to sublinear above, laxly oblong below. Perichaetial leaves erect, pale, plicate, lanceolate, slenderly long-acuminate. Setae elongate, smooth; capsules inclined to horizontal, ± curved, oblong-cylindric, brown; annulus readily deciduous; operculum conic; peristome broadly lance-subulate, yellow-brown and cross-striolate below, nearly smooth at the tips, bordered, trabeculate; endostome as long as the teeth, yellowish, nearly smooth, the basal membrane high, segments lance-subulate, keeled, not or very narrowly perforate, cilia in 3's, delicate but well developed. Calyptrae cucullate, smooth, naked.—The name refers to the marshy habitats in which the various species are found.

**Helodium blandowii** (Web. & Mohr) Warnst.—Plants in dense, yellow or light-green masses 5-12 cm. high. Stems red-brown, erect, closely 1-pinnate; branches nearly equal, straight, somewhat tapered, wide-spreading. Stem leaves erect or somewhat erect-spreading, 1.2-1.5 mm. long, broadly ovate, gradually short-acuminate, abruptly narrowed to the insertion and ciliate near the base; margins serrulate or sinuate-serrulate above; costa about 4/5 the leaf length; upper cells oblong-fusiform or oblong-rhomboidal, 3-5:1, firm-walled, strongly unipapillose at back near the upper ends or nearly centrally. Branch leaves erect or ± erect-incurved and moderately contorted when dry, ± erect-spreading when moist, 0.5-0.8 mm. long, narrowly ovate, acute, ending in a sharp, unipapillose cell. Autoicous. Setae 40-60 mm. long, reddish; capsules 3-4 mm. long; annulus well developed, of about 2 rows of cells; operculum conic, blunt to apiculate; stomata in the neck; cilia of endostome in 3's (or occasionally paired), nodulose. Spores 11-15 $\mu$, very minutely papillose.—n = 12.

Darlington, Mosses of Michigan, fig. 108. Grout, Mosses with Hand-lens and Microscope, figs. 123c, 124, 132 (as *Thuidium*).—**Fig. 720-723.**

In wooded or open bogs or swamps, frequently in brushy thickets along streams or ditches. Circumpolar; Alaska to Greenland and south to Colorado and Arizona, Illinois, Ohio, and New York.




*Thuidium delicatulum* var. *radicans*. 718. Stem leaves. 719. Perichaetial leaf.

*Helodium blandowii*. 720. Habit. 721. Stem and branch leaves. 722. Upper cells of leaf. 723. Paraphyllium.

*Helodium blandowii* var. *helodioides*. 724. Stem and branch leaves. 725. Upper cells of branch leaf.

*Helodium paludosum*. 726. Stem and branch leaves. 727. Upper cells of branch leaf.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge (Carp Creek), Douglas Lake, Mud Lake, Little Lake 16. EMMET CO.–Wilderness State Park, Gladys Bog, Galloway Bog, Conway Bog, Bear Creek Township. MACKINAC CO.–Peggley Lake. PRESQUE ISLE CO.–Evergreen Beach, Kelsey Pond.

*Helodium blandowii* has somewhat the look of a *Thuidium*. The erect, once-pinnate stems felted with filiform paraphyllia, the softness of the leaves, and the swampy habitat aid in recognition. In this, and other species of *Helodium*, the

paraphyllia are found not only on stems and branches but also on the bases of the costa.

The var. **helodioides** (Ren. & Card. *ex* Röll) Crum, Steere & Anders. (fig. 724-725) may be expected in hardwood or tamarack swamps. The plants are somewhat smaller and somewhat more rigid, with stems spreading and loosely branched or irregularly pinnate and with leaves costate nearly to the apex.

**Helodium paludosum** (Sull.) Aust. (fig. 726-727), known from southern Michigan, has longer cells (5-6:1), smooth or weakly papillose at back because of projecting upper angles.

## AMBLYSTEGIACEAE

Plants small to robust, in loose to dense tufts or mats, mostly in wet places, sometimes submerged. Stems creeping to suberect, irregularly to pinnately branched; paraphyllia sometimes abundant but mostly lacking. Stem and branch leaves similar, in many rows, rarely somewhat flattened, imbricate or erect to wide-spreading or sometimes squarrose-recurved, frequently secund, symmetric, mostly oblong-lanceolate and acuminate, rarely ovate or elliptic and blunt or even rounded at the apex; costa single and sometimes very long or short and often forked, double, or lacking; cells oblong-hexagonal to long-linear, usually smooth, often differentiated at the basal angles and sometimes abruptly inflated in well-marked alar groups. Perichaetia lateral; perichaetial leaves differentiated. Setae elongate, red or red-yellow, smooth; capsules inclined to horizontal, oblong-cylindric, asymmetric and usually strongly curved, constricted below the mouth when dry and empty, smooth; annulus mostly differentiated; operculum conic or convex-conic, acute or mammillate to apiculate, rarely short-rostrate; stomata in the neck; peristome double, the 16 teeth lanceolate, cross-striolate below, papillose above, bordered, trabeculate; endostome with a high basal membrane, broad, keeled and often perforate segments, and usually well-developed cilia. Spores spherical. Calyptrae cucullate, naked.—A family characteristic of wet habitats. The arcuate capsules and yellow-brown peristome teeth contrast with the shorter capsules and red-brown teeth of the Brachytheciaceae typical of dryer habitats.

1. Paraphyllia present, generally numerous, not restricted to branch bases — 1. *Cratoneuron*
1. Paraphyllia none or few and restricted to branch bases
 2. Leaves ± secund
  3. Leaves very concave, short-acuminate, imbricate and usually ± secund, sometimes strongly so; costa well developed, often single and double on the same plants — 7. *Hygrohypnum*
  3. Leaves not particularly concave, long-acuminate, not imbricate, falcate-secund throughout or occasionally only at tips of stems and branches; costa single — 6. *Drepanocladus*
 2. Leaves erect or spreading, not secund
  4. Leaves lanceolate or ovate-lanceolate, variously acuminate
   5. Leaves gradually or abruptly narrowed from an ovate base to a channeled acumen, mostly wide-spreading or squarrose above the base; costa single or short and double — 2. *Campylium*
   5. Leaves gradually narrowed from a lanceolate or ovate-lanceolate base to a rather flat acumen, erect or ± spreading from the insertion; costa single
    6. Plants rather small to fairly large; cells linear-rhomboidal to oblong-rhomboidal — 3. *Leptodictyum*
    6. Plants small; leaf cells short, oblong-rhombic to shortly rhomboidal
     7. Costa not particularly strong, usually ending near the leaf middle, rarely disappearing in the acumen or subpercurrent — 5. *Amblystegium*
     7. Costa very stout, subpercurrent to excurrent — 4. *Hygroamblystegium*
  4. Leaves broad and elliptic or nearly rounded, broadly rounded at the apex and sometimes apiculate

8. Costa single and well developed — 8. *Calliergon*
8. Costa short and double or lacking
  9. Alar cells clearly differentiated in conspicuous groups — 9. *Calliergonella*
  9. Alar cells not differentiated or only a few somewhat inflated in small and inconspicuous groups — 10. *Scorpidium*

## 1. **Cratoneuron** (Sull.) Spruce

Plants medium-sized to fairly robust, in dense, often deep cushions, green, bluish-green or yellow to brown, usually somewhat radiculose below. Stems creeping or, more typically, crowded and erect or ascending, regularly or sometimes irregularly pinnate; paraphyllia present, usually rather abundant, sometimes very few and difficult to find. Leaves striate or plicate, sometimes erect or erect-spreading but mostly falcate-secund, slenderly acuminate from a broadly ovate or ovate-lanceolate, sometimes decurrent base; margins plane or slightly recurved near the insertion, serrulate all around or at the base and sometimes also at the apex; costa single, sometimes very strong, disappearing in the subula to percurrent; cells ± incrassate, smooth or rarely papillose at back because of thickened cell angles, short and oblong or oblong-rhomboidal to rather long and linear, somewhat larger and inflated in a few rows across the insertion or abruptly inflated and thin- or thick-walled in well-developed, concave alar groups. Dioicous; perichaetial leaves elongate, erect, lance-acuminate. Capsules curved-cylindric; annulus of 2-3 rows of small cells; operculum acute, stoutly apiculate, or short-rostrate; endostome with well-developed, nodulose cilia.—The name refers to a strong costa.

**Cratoneuron filicinum** (Hedw.) Spruce—Plants medium-sized to fairly robust, often rigid, in extensive cushions up to about 12 cm. high but usually considerably less, green, yellowish, or brownish, somewhat radiculose below, radiculose in tufts above. Stems spreading or more often crowded and erect-ascending, irregularly or more typically pinnately branched; paraphyllia usually none or few but sometimes fairly numerous, variously lanceolate, unbranched. Stem leaves erect or erect-spreading, sometimes secund to falcate-secund, ± striate, 1-1.8 mm. long, ovate-lanceolate to broadly ovate, rather abruptly acuminate, the acumen usually not flexuose and twisted; margins often somewhat recurved at the extreme base, serrulate nearly all around (the acumen nearly entire); costa rather strong, percurrent or ending in the acumen somewhat below the apex, rarely filling the apex; cells smooth, firm-walled, usually shortly oblong, sometimes oblong-rhomboidal, about 3-6:1, abruptly inflated in concave, hyaline or yellow-brown, thin- or thick-walled alar groups. Branch leaves shorter and narrower, usually ± falcate-secund. Setae 25-35 mm. long; capsules 2-2.5 mm. long; operculum apiculate to short-rostrate; cilia in 3's and 4's. Spores 15-18 $\mu$, very finely roughened.—n = 10, 11, 20, 30.

Darlington, Mosses of Michigan, fig. 114. Grout, Mosses with Hand-lens and Microscope, Pl. 75. Welch, Mosses of Indiana, fig. 174.—**Fig. 728-732.**

On wet soil or rocks in seepage or overflow from springs or backwater of brooks; apparently limited to calcareous habitats. Europe, Asia, Africa, Madeira; New Zealand; Guatemala; Alaska and British Columbia to Newfoundland, south to California, New Mexico, Texas, and Alabama.

CHEBOYGAN CO.—Reeses Bog, Gorge of Carp Creek, Iron Bridge, Mill Creek, Grass Lake, Grass Bay. EMMET CO.—Maple River, Sturgeon Bay Point, Cecil Bay, Alanson, Ramona Beach. MACKINAC CO.—Bois Blanc Island, Mackinac Island. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach.

*Cratoneuron filicinum* is recognized by its seepy, calcareous habitat and upright or decumbent, pinnately branched stems ending in an unbranched extension pointing

upward like a long, skinny finger curved at the tip. The paraphyllia are few and usually difficult to find, but the rhizoids in tufts along the stems are distinctive. The plants are often harsh and rigid owing to the deposition of calcium carbonate around the older portions. The other species known from the state, C. **commutatum** (Hedw.) Roth, is much more like a *Drepanocladus* in appearance and structure but has an abundance of paraphyllia. The epithet *commutatum* refers to changes effected by deposition of limey material from the water resulting in a degree of petrification. (Chromosome numbers reported for *C. commutatum* are n = 7, 10.)

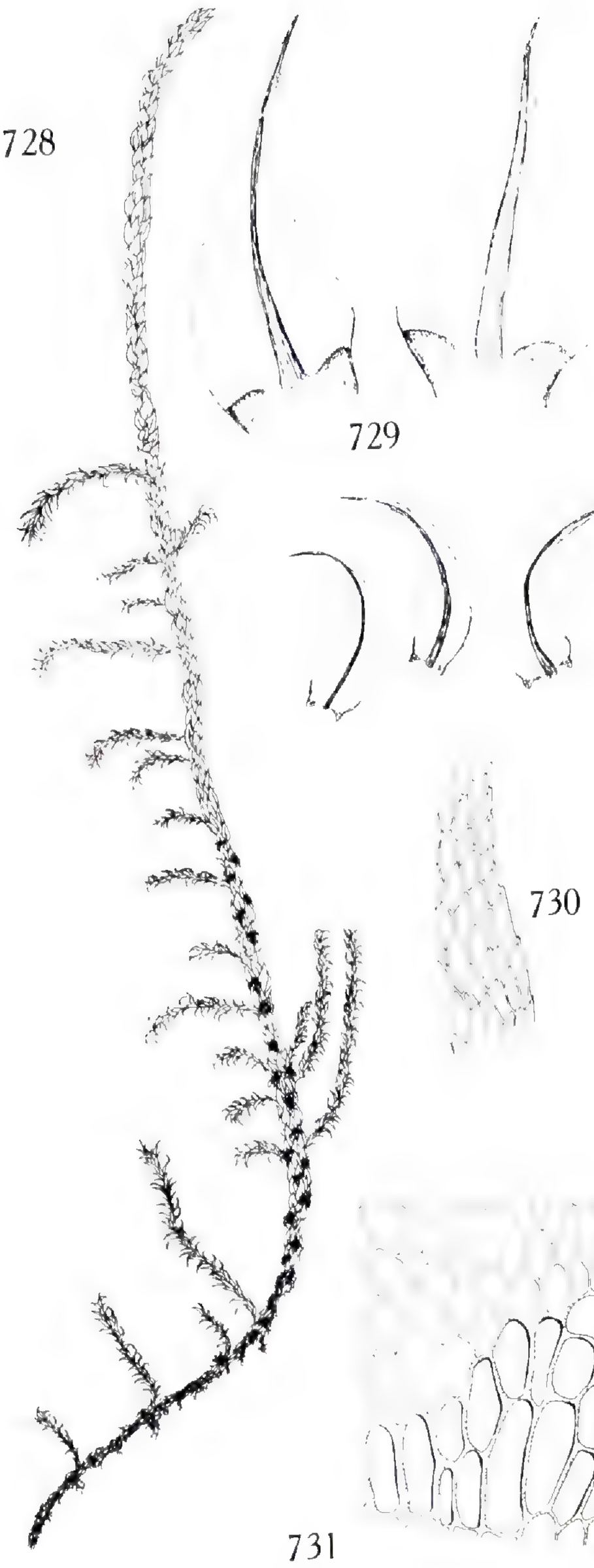
## 2. **Campylium** (Sull.) Mitt.

Plants small and slender to moderately robust, in green to yellow or golden-brown, often shiny tufts or mats. Stems creeping or sometimes crowded and erect-ascending, irregularly to subpinnately branched; paraphyllia none or sometimes few, at the branch bases. Leaves suberect, ovate or cordate, shortly decurrent at the base and gradually to rather abruptly narrowed to a long, channeled acumen which is usually wide-spreading to squarrose-recurved; margins erect, mostly entire; costa single, slender, and ± elongate or short, double, or lacking; cells narrowly prosenchymatous to linear, smooth, ± differentiated in somewhat excavate alar groups (small, quadrate, and firm-walled or pale, lax, and ± inflated). Perichaetial leaves sheathing at base, lance-subulate, striate. Capsules curved, subcylindric; annulus present; operculum acute or apiculate; endostome with usually perforate segments and 1-3 well-developed, nodulose cilia.—The name, signifying curved, may refer to the leaves which are commonly curved and spreading or possibly to the curved capsules.

1. Costa none or very short and double
   2. Plants slender, with creeping stems; leaves smooth, finely serrulate all around; alar cells small, quadrate — 1. *C. hispidulum*
   2. Plants usually moderately robust, with erect-ascending stems; leaves generally ± striolate when dry, entire; alar cells inflated, subrectangular
      3. Leaves crowded, striolate when dry, erect or ± spreading from an erect base, gradually tapered; plants rather robust — 5. *C. stellatum*
      3. Leaves not crowded, not or slightly striolate when dry, wide-spreading from the insertion, abruptly acuminate; plants smaller — 5a. *C. stellatum* var. *protensum*
1. Costa single, ending at or somewhat above the leaf middle
   4. Leaves erect-spreading, gradually acuminate; alar cells enlarged and inflated — 4. *C. polygamum*
   4. Leaves wide-spreading to squarrose, abruptly acuminate; alar cells not or only slightly inflated
      5. Leaves crowded, often somewhat secund at tips; upper cells linear; alar cells sub-quadrate, firm-walled; dioicous — 2. *C. chrysophyllum*
      5. Leaves remote, not secund; upper cells shortly rhomboidal (4-6:1); alar cells shortly oblong, not noticeably firm-walled; autoicous — 3. *C. radicale*

1. **Campylium hispidulum** (Brid.) Mitt.—Very slender plants in bright-green or yellowish mats. Stems creeping, irregularly branched. Leaves squarrose, 0.5-0.6 mm. long (or stem leaves rarely 1 mm. long), very concave, ovate, rather abruptly long-acuminate; margins serrulate nearly all around; costa very short and double or none; upper cells oblong-rhomboidal; alar cells numerous, subquadrate and shortly oblong. Autoicous. Setae 8-15 mm. long; capsules 1-2 mm. long, constricted below the mouth when dry and empty; operculum stoutly and bluntly oblique-apiculate; exostome teeth brown; endostome pale-brownish, with non-perforate segments and cilia in groups of 2 and 3. Spores 9-13 $\mu$, very finely roughened.—n = 14.

Conard, How to Know the Mosses, (ed. 2) fig. 256. Grout, Mosses with Hand-lens and Microscope, fig. 168. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 41, (ed. 2) Pl. 45. Welch, Mosses of Indiana, fig. 175.—**Fig. 733-735.**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*Cratoneuron filicinum.* 728. Habit. 729. Stem and branch leaves. 730. Upper cells at margin of leaf. 731. Alar cells. 732. Paraphyllia.

*Campylium hispidulum.* 733. Habit. 734. Leaves. 735. Upper cells of leaf.

*Campylium chrysophyllum.* 736. Leaves.

*Campylium radicale.* 737. Leaf. 738. Alar cells.

On soil, rocks, and logs, usually in rather moist forests; probably a calciphile. Circumpolar; Saskatchewan to Labrador, south to the Gulf of Mexico; Mexico; reported from northern South America.

CHEBOYGAN CO.–Douglas Lake, Reeses Bog, Carp Creek, Colonial Point, Mud Lake. EMMET CO.–Arnott Lake, Galloway Bog, Pellston Hills, Middle Village, Wilderness State Park. MACKINAC CO.–Bois Blanc Island, Mackinac Island, McKays Creek, Ozark. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Hoeft State Park, Ocqueoc Falls, Rainy River Falls.

*Campylium hispidulum* is our smallest representative of the genus, recognized by crowded, cordate leaves abruptly narrowed to a wide-spreading or squarrose, channeled acumen. The costa is very short and double (or none), in contrast to the single costa of *C. chrysophyllum.*

2. **Campylium chrysophyllum** (Brid.) J. Lange–Plants variable in size but rather small, in green, yellow-green, or yellow-brown, sometimes ± shiny mats. Stems creeping, freely and irregularly branched. Leaves typically wide-spreading to squarrose, often somewhat secund at the tips, ovate or lanceolate, rather abruptly narrowed to a channeled acumen, rounded to the base, usually faintly striolate when dry; margins entire above, not or slightly sinuate at the base; costa slender, single, 1/2-2/3 the leaf length; upper cells oblong-linear; alar cells quadrate to short-oblong, not inflated, firm-walled. Dioicous. Setae 10-27 mm. long, becoming red; capsules 2-3 mm. long; operculum stoutly oblique-apiculate; exostome teeth yellow-brown; endostome pale-brownish, finely papillose, with non-perforate segments and cilia in groups of 2-3. Spores 13-15 $\mu$, faintly roughened.–n = 9, 20.

Breen, Mosses of Florida, Pl. 69 (figs. 1-3). Darlington, Mosses of Michigan, fig. 115. Grout, Mosses with Hand-lens and Microscope, fig. 169. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 41, (ed. 2) Pl. 45. Welch, Mosses of Indiana, fig. 177.–**Fig. 736.**

On rocks, soil, rotten wood, and bases of trees in moist to wet woods. Circumpolar; Mexico, Guatemala, Greater Antilles, northern South America; British Columbia to Newfoundland, south to Oregon, Arizona, and Colorado; throughout eastern North America.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Douglas Lake, Iron Bridge, Lancaster Lake, Mud Lake, Cheboygan, Mill Creek, Grass Bay. EMMET CO.–Arnott Lake, Maple River, Stutsmanville, Cecil Bay, Big Stone Bay, Five Mile Creek. MACKINAC CO.–Mackinac Island, St. Martins Point, Hessel, Ozark. PRESQUE ISLE CO.–Mast Point, Hammond Bay, Evergreen Beach, Presque Isle Lighthouse, Ocqueoc Falls, Rainy River Falls, Grand Lake, Clinton Lake.

*Campylium chrysophyllum* is rather small but considerably stouter than *C. hispidulum,* from which it is easily distinguished by its leaves with a single costa. The leaves are crowded and typically squarrose from a clasping base, but occasionally they are slightly to strongly secund.

3. **Campylium radicale** (P.-Beauv.) Grout–Slender plants in soft, loose, light-green or yellowish mats, resembling an *Amblystegium* in habit. Leaves remote, 1-1.3 mm. long, wide-spreading from the insertion, ovate, abruptly narrowed to a slender, channeled acumen, decurrent; margins plane, entire or nearly so; costa single, slender, 1/2-2/3 the leaf length; upper cells rather shortly rhomboidal, 4-6:1; alar cells somewhat enlarged, oblong, hyaline. Autoicous. Setae 3-4 cm. long; capsules about 2 mm. long; peristome teeth brown; cilia of endostome 1-3. Spores ca. 9-11 $\mu$, finely roughened.

Breen, Mosses of Florida, Pl. 69 (figs. 8-10). Grout, Mosses with Hand-lens and Microscope, fig. 175 (8-10), as *Hypnum radicale, H. bergenense,* & *Amblystegium hygrophilum.* Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 38 & (ed. 2) Pl. 42 (as *Amblystegium radicale*).–**Fig. 737-738.**

On decaying leaves, twigs, humus, and mucky soil in swampy habitats. Europe; probably common but usually overlooked in much of eastern North America.

CHEBOYGAN CO.–Douglas Lake, Livingston Bog, Cheboygan.

*Campylium radicale* is somewhat like an *Amblystegium* in aspect, because of its growth in thin, loose mats and its remote leaves widely spreading from the insertion, but it has channeled leaf tips, a characteristic of *Campylium* never found in *Amblystegium.* Among our species of *Campylium,* it is rather easily recognized by remote leaves spreading from the insertion, broad at the base, abruptly acuminate, and singly costate.

4. **Campylium polygamum** (BSG) C. Jens.–Plants moderately robust, in loose or dense, yellow-green to golden-brown, slightly shiny mats. Stems prostrate or ascending, irregularly branched. Leaves erect-spreading or somewhat spreading, 2-2.5 mm. long, ovate-lanceolate, gradually narrowed to a long, slender, channeled acumen, entire; costa slender, single and ending at or somewhat above the midleaf (rarely shorter and ± forked); upper cells linear, becoming ± thick-walled and sometimes porose with age; cells at middle of the insertion incrassate and porose, those in the alar regions short-rectangular, inflated and often golden-brown, in distinct groups. Polygamous. Setae 2-4 cm. long; capsules about 2.5 mm. long. Spores ca. 16 $\mu$, finely papillose.–n = 11, 20.

Breen, Mosses of Florida, Pl. 69 (figs. 4-7). Grout, Mosses with Hand-lens and Microscope, fig. 170. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 42, (ed. 2) Pl. 46. Welch, Mosses of Indiana, fig. 178.–**Fig. 739.**

On soil or humus in meadows, swamps, or wooded bogs. Europe (and presumably nearly cosmopolitan); widespread in North America, but scattered from British Columbia to Quebec and south to the Gulf.

CHEBOYGAN CO.–Reeses Bog, Burt Lake, Douglas Lake. EMMET CO.–Pellston Hills, Cecil Bay. MACKINAC CO.–Bois Blanc Island, Peggley Lake, Rexton, PRESQUE ISLE CO.–Mast Point, Evergreen Beach.

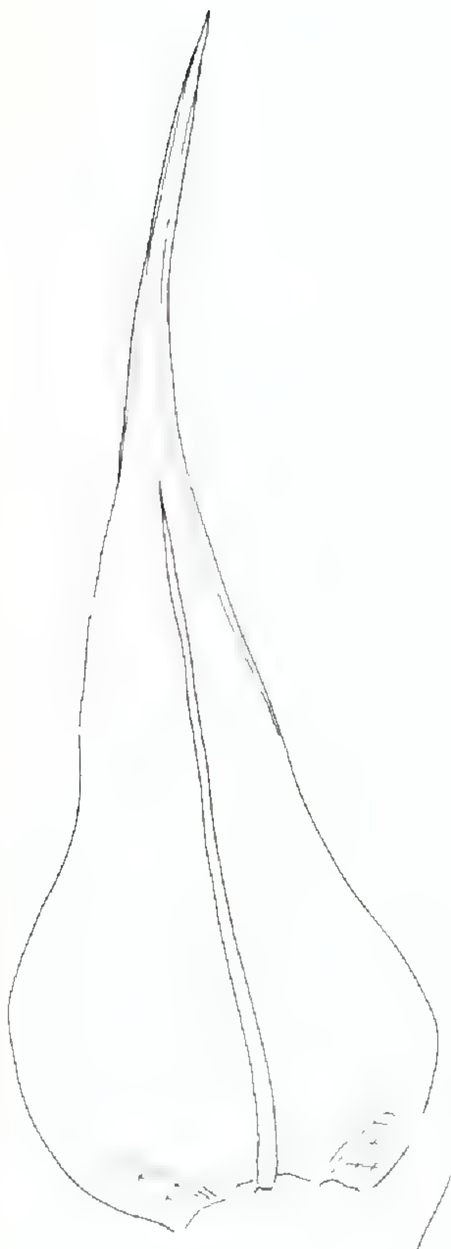
*Campylium polygamum* resembles *C. stellatum,* especially in size, but has leaves less spreading, narrower, and singly costate. As in *C. stellatum,* the alar cells are rather well differentiated.

5. **Campylium stellatum** (Hedw.) C. Jens.–Plants moderately robust, in loose or dense, yellow, golden, or brownish, ± shiny mats. Stems irregularly branched, ascending. Leaves crowded, 1.5-3 mm. long, striolate when dry, broad and cordate-ovate at the base, gradually narrowed to a long, channeled, suberect or more typically widely spreading acumen, subentire; costa lacking or short, slender, and single or forked; upper cells linear, ± thick-walled, becoming porose with age; alar cells rather conspicuously differentiated, enlarged, thin-walled, hyaline, short-oblong (becoming brownish and thicker-walled with age). Dioicous. Setae 2-3.5 cm. long; capsules about 3 mm. long. Spores about 16 $\mu$, finely papillose.–n = 10, 18+2, 20, 22.

Grout, Mosses with Hand-lens and Microscope, Pl. 77. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 42, (ed. 2) Pl. 46. Welch, Mosses of Indiana, fig. 176.–**Fig. 740-742.**

On soil or humus in wet, calcareous habitats, such as rich fens, meadows, roadside ditches, and seepage around springs. Circumpolar; Greenland to Alaska and south to Colorado, Ohio, and Pennsylvania.

CHEBOYGAN CO.–Reeses Bog, Mill Creek, Grass Bay, Indian River. EMMET CO.–Arnott Lake, Wycamp Lake, Cecil Bay, Wilderness State Park, Waugoshance Point, Conway Bog, Ramona Beach. MACKINAC CO.–St. Martins Bay, Nunns Creek, St. Martins Point, Epoufette, Rexton, PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Clinton Lake.



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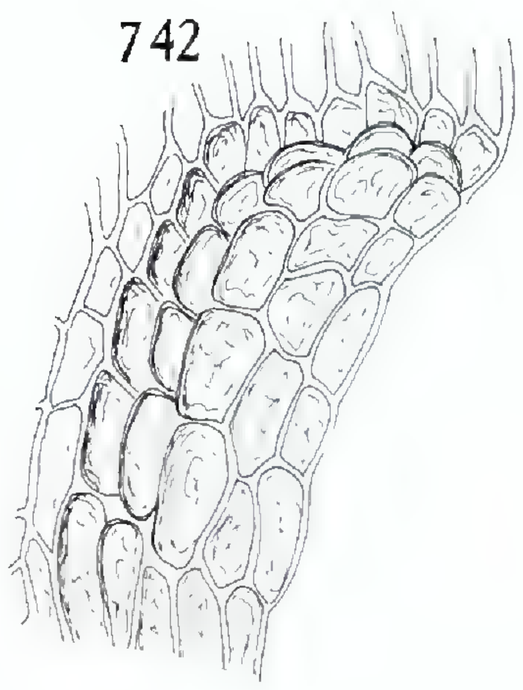

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*Campylium polygamum.* 739. Leaves.
*Campylium stellatum.* 740. Portion of branch. 741. Leaf. 742. Alar cells.

*Campylium stellatum* is highly characteristic of calcareous fens. It is typically robust, with a compact and tufted manner of growth and a rich, golden color. The leaves are more or less squarrose-spreading and, when dry, longitudinally striolate. As in *C. polygamum,* which can be confused with it, *C. stellatum* has somewhat inflated alar cells, but it lacks a costa. (The name refers to spreading leaf tips giving the stems and branches something of a star-like appearance at their tips.)

5a. Var. **protensum** (Brid.) Bryhn *ex* Grout–Plants rather slender. Leaves not crowded, not or slightly striolate when dry, wide-spreading to squarrose, mostly from the insertion, abruptly narrowed from a broad base to a long, slender acumen.–n = 10.

Grout, Moss Flora of North America 3: Pl. 17A (fig. 3).

CHEBOYGAN CO.–Reeses Bog, Grass Bay.

In open, boggy habitats, such as sedge meadows or margins of beach pools. Europe, Asia, and North America, presumably ranging with the species but relatively uncommon.

Smaller than the typical variety and somewhat resembling *Campylium chrysophyllum.* When well developed, it also bears a similarity to *Rhytidiadelphus loreus,* though constructed on a smaller scale.

### 3. **Leptodictyum** (Schimp.) Warnst.

Plants slender to fairly robust, in thin, usually dull, dirty-green or yellowish, sometimes shiny mats, usually in very wet places, sometimes submerged. Stems creeping or ascending, freely and irregularly or sometimes subpinnately branched. Leaves soft, mostly widespreading and occasionally loosely complanate, oblong-lanceolate, acute or acuminate, not channeled above, smooth; margins plane and entire or nearly so; costa single, slender, ending at or above the leaf middle, rarely subpercurrent; cells ± elongate, oblong-hexagonal to rhomboidal or long-linear, smooth, mostly thin-walled, broader and oblong at base, sometimes ± differentiated at the basal angles. Autoicous; perichaetial leaves lance-acuminate, ± plicate. Capsules curved; annulus differentiated; operculum blunt or acute; endostome with perforate or non-perforate segments and filiform, ± nodose cilia in 2's-4's.—The name refers to the fine network formed by the outlines of the leaf cells (and is not particularly appropriate).

1. Leaves 2.5-4 mm. long; leaf cells linear-rhomboidal, 8-15:1 — 1. *L. riparium*
1. Leaves 2 mm. or less long; leaf cells oblong-rhomboidal, 2-6:1
  2. Leaves broadly short-acuminate — 2. *L. brevipes*
  2. Leaves slenderly acuminate — 3. *L. trichopodium*

1. **Leptodictyum riparium** (Hedw.) Warnst.—Medium-sized to relatively robust, green, yellowish, or golden to brownish plants in loose, flat mats. Stems creeping; branches usually horizontal and wide-spreading. Leaves rather distant, wide-spreading (and often appearing somewhat 2-ranked), 2.5-4.5 mm. long, lanceolate, gradually long-acuminate; costa ½-¾ the leaf length; upper cells long, linear-rhomboidal (about 8-15:1), those at the basal angles laxly rectangular. Setae 13-25 mm. long; capsules 2.2-2.5 mm. long. Spores 11-13 $\mu$, finely papillose.—n = 9+1, 10, 12, 20, 24, 36, 40, 48, 96 (and experimentally 12, 48, 96).

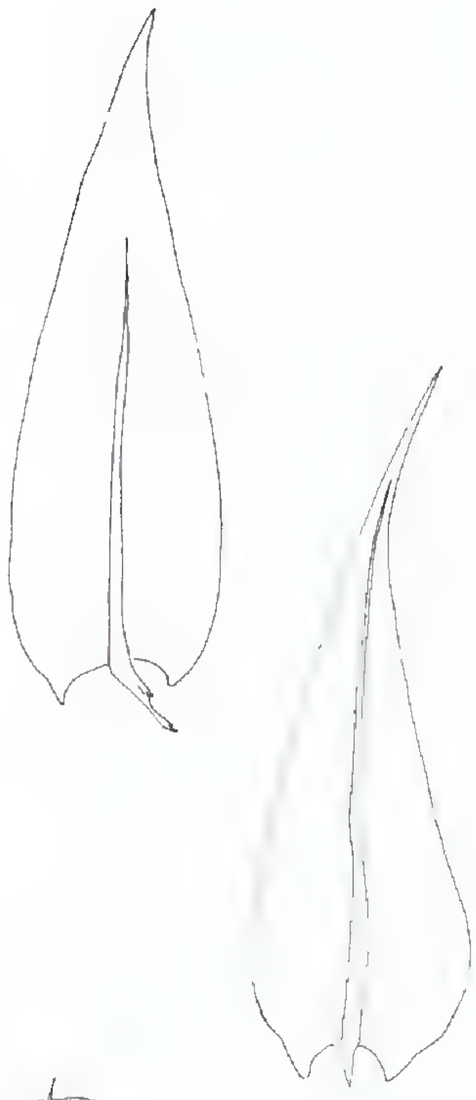
Conard, How to Know the Mosses, (ed. 2) fig. 225. Darlington, Mosses of Michigan, fig. 111. Grout, Mosses with Hand-lens and Microscope, fig. 176 (as *Amblystegium*), Moss Flora of North America 3: Pl. 15A (figs. 1-6). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 38 & (ed. 2) Pl. 42 (as *Amblystegium*). Welch, Mosses of Indiana, fig. 155, 156 (as fo. *longifolium* ), 158 (as fo. *obtusum*).—**Fig. 743-746.**

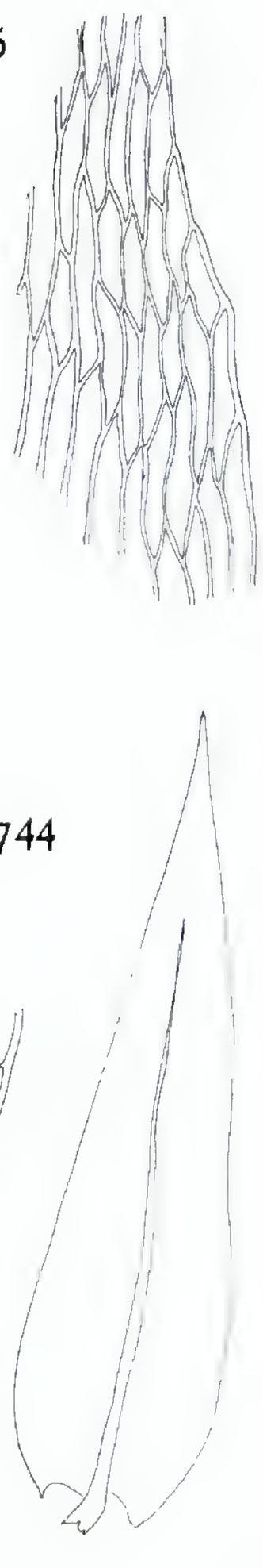
On humus, leaf litter, and twigs and branches on the ground in wet places, commonly in wooded swamps in shallow depressions flooded in spring. Circumpolar; widespread in North America; Mexico, Guatemala, Cuba, and Haiti.

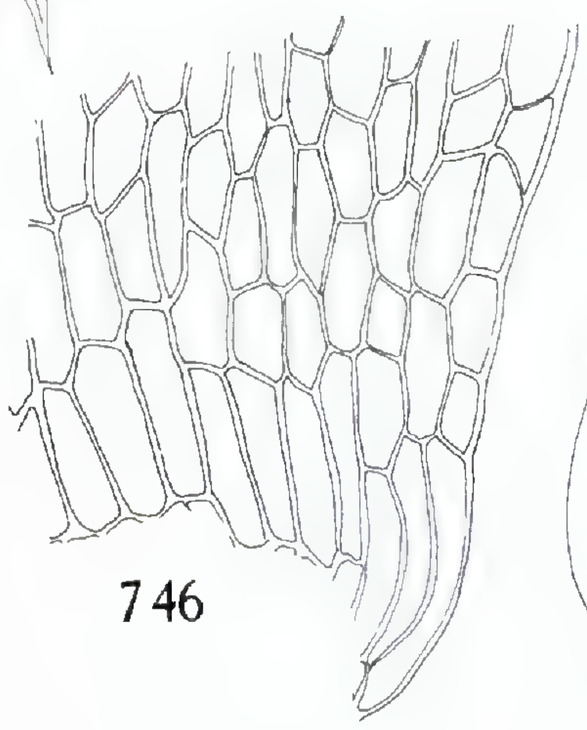
CHEBOYGAN CO.—Burt Lake, Douglas Lake, Reeses Bog, Gorge of Carp Creek, Iron Bridge, Fontinalis Run, Smiths Bog, Black River, Cheboygan, Mill Creek. EMMET CO.—Pleasantview Swamp, Carp Lake, Levering. PRESQUE ISLE CO.—Hammond Bay.

Like other mosses of wet habitats (and most members of this "wet family"), *Leptodictyum riparium* is extremely variable. It grows most commonly on the floor of hardwood swamps where it is submerged in the spring but becomes stranded as the water table lowers. Typically it has straight, wide-spreading, rather complanate, entire, long-pointed leaves with long cells.

We have both the fo. **longifolium** (Schultz) Grout, a robust, usually submerged form with leaves 3.5-4.5 mm. long, ending in a long, filiform acumen, and the fo. **fluitans** (Lesq. & James) Grout, a robust, submerged form with leaves about 3 mm. long and shorter-acuminate than those of the fo. *longifolium.* Neither seems very distinctive when compared with other expressions of this plastic species.




*Leptodictyum riparium*. 743. Habit. 744. Three leaves. 745. Upper cells of leaf at margin. 746. Cells of alar region.

2. **Leptodictyum brevipes** (Card. & Thér. *ex* Holz.) Broth.–Rather small plants. Stems creeping. Leaves stiffly erect-spreading and concave when dry, more spreading when moist, about 1.2-2 mm. long, ovate or ovate-lanceolate, gradually short-acuminate; costa extending about 2/3 the leaf length; upper cells oblong-rhomboidal, 4-6:1; basal and alar cells subquadrate to short-rectangular, not conspicuously differentiated. Setae 1-2.5 cm. long; capsule 2-2.5 mm. long. Spores 9-13 $\mu$, faintly roughened.

Conard, How to Know the Mosses, (ed. 2) fig. 226. Grout, Moss Flora of North America 3: 15B, 16 (fig. 2a-h). Welch, Mosses of Indiana, fig. 160.

In moist, disturbed places, especially among grasses in partially shaded lawns, sometimes on bark at base of trees, decayed wood, and other substrata. Scattered in eastern North America from Minnesota and Missouri to Pennsylvania and West Virginia.

The broad, rather stiffly erect-spreading, concave leaves with shortly acuminate tips and rather short cells are distinguishing features. *Leptodictyum brevipes* has not

been found in Michigan, although reported earlier from the Douglas Lake region. Because of its weedy occurrence across a broad range from Minnesota to Michigan, and because it has been generally misunderstood, it seems likely to occur in the state and no doubt commonly.

3. **Leptodictyum trichopodium** (Schultz) Warnst.–Plants in flat, loose, light-green or yellowish mats. Branches spreading or ascending. Leaves not crowded, erect- to wide-spreading, 1.3-1.9 mm. long, ovate-lanceolate, rather gradually acuminate; margins subentire to ± distinctly serrulate, especially at base; costa 0.6-0.7 the leaf length; upper cells rhomboidal, 3-6:1, cells at base short-oblong in several marginal rows. Setae 10-30 mm. long; capsules 2-2.5 mm. long. Spores 11-15 $\mu$, finely papillose.–n = 20 (as *L. kochii*).

Conard, How to Know the Mosses, (ed. 2) fig. 217a-e & f (as var. *kochii*). Grout, Mosses with Hand-lens and Microscope, fig. 173 (as *Amblystegium kochii*), Moss Flora of North America 3: Pl. 16 (fig. 12). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 38 & (ed. 2) Pl. 42 (as *Amblystegium kochii*). Welch, Mosses of Indiana, fig. 161, 162 (as var. *kochii*).–**Fig. 747-749.**

On various substrata in wet, shady places, particularly in swamps. Circumpolar; widespread in North America, including Mexico.

CHEBOYGAN CO.–Douglas, Burt, and Mud Lakes, Mill Creek. EMMET CO.–Maple River.

Smaller than *L. riparium* and somewhat resembling a large expression of *Amblystegium varium* but with softer leaves, a shorter costa, and longer cells with thinner walls. I make no attempt to distinguish *L. trichopodium* from its var. *kochii* (BSG) Broth.

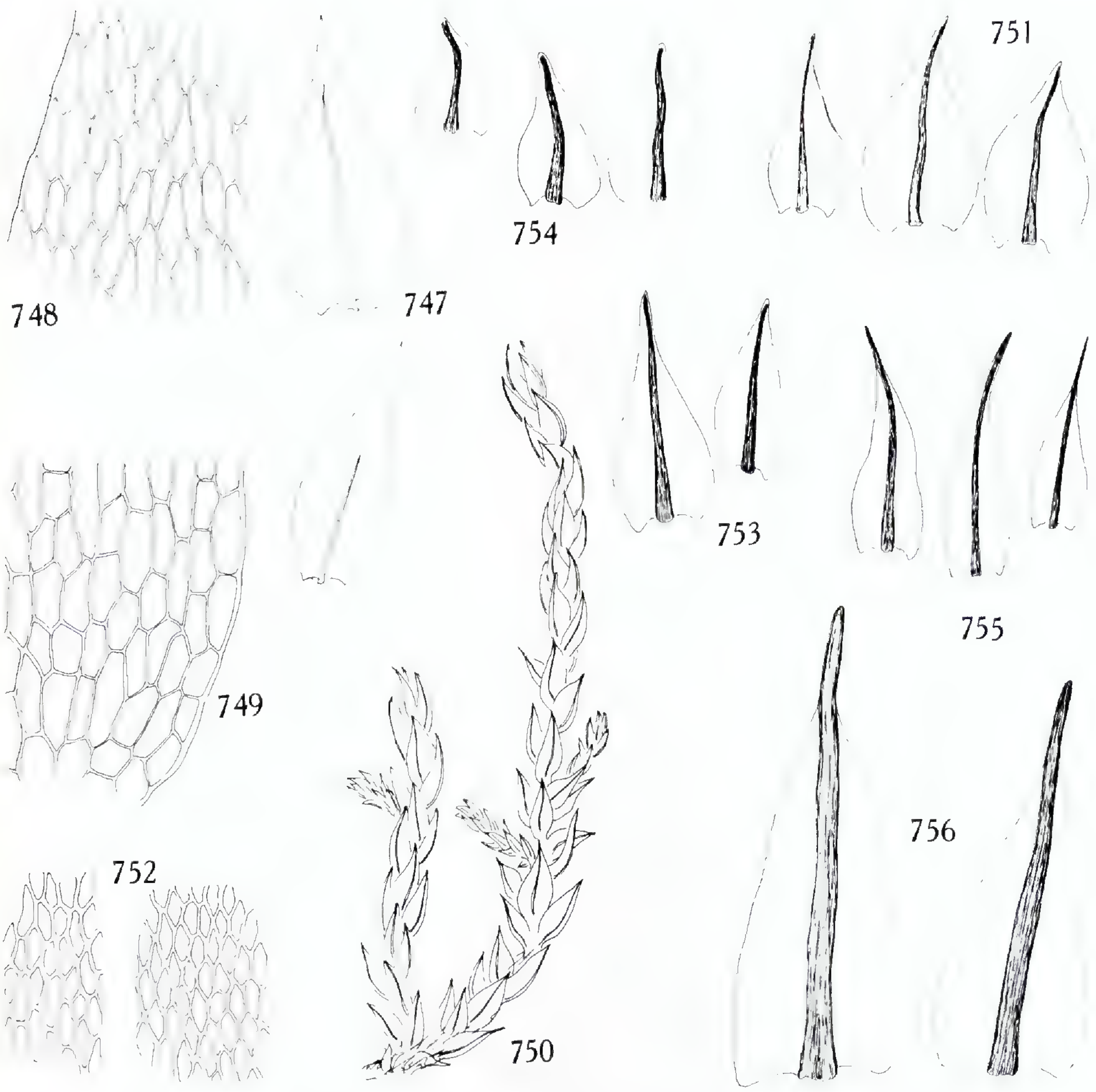
4. **Hygroamblystegium** Loeske, *nom. cons.*

Plants rather small to large and coarse, in soft or rigid, dull, dark-green, blackish, or yellowish-brown mats in wet places, often submerged. Stems prostrate or crowded and ascending, freely and irregularly branched, often denuded of leaves in older parts; paraphyllia limited to branch bases. Leaves erect or somewhat incurved or rarely subsecund, oblong-ovate or oblong-lanceolate, gradually acuminate, usually bluntly acute, not or only slightly decurrent; margins plane, entire or nearly so; costa broad, ending at or near the apex or nearly filling the acumen to excurrent; cells firm, smooth, oblong-rhombic to shortly oblong-rhomboidal (about 2-6:1), generally somewhat enlarged and shortly oblong and thick-walled in 1 or more rows across the insertion, the alar cells not differentiated. Autoicous; perichaetial leaves erect, lance-acuminate. Capsules curved-cylindric; annulus well developed, of 2 rows of cells; operculum acute to apiculate; endostome with not or narrowly perforate segments and well-developed, nodose cilia in 2's and 3's.–The name signifies an *Amblystegium* of aquatic habitats. The genus is scarcely more than a large edition of *Amblystegium* with a notably stout costa.

1. Plants large, coarse, and usually rigid; costa very broad (110-140 $\mu$ wide), terete, filling the apex of the leaf and stoutly and shortly excurrent ..... 2. *H. noterophilum*
1. Plants rather small, softer; costa much narrower, not terete, ending near the leaf apex or excurrent as a slender point
  2. Leaves gradually acuminate and bluntly acute; costa ending near the apex ..... 1. *H. tenax*
  2. Leaves rather abruptly subulate; costa excurrent as a slender point ..... 1a. *H. tenax* var. *spinifolium*

1. **Hygroamblystegium tenax** (Hedw.) Jenn.—Plants rather small, dark-or yellow-green, usually rather soft. Stem leaves not crowded, erect or sometimes wide-spreading, somewhat incurved when dry, (0.7)1-1.5 mm. long, ovate or ovate-lanceolate, gradually short-acuminate; costa yellowish, fairly strong, disappearing near the apex; upper cells oblong-rhombic, 2-3:1, at the insertion 2-3 rows somewhat enlarged, usually becoming ± yellowish. Branch leaves oblong-lanceolate (or occasionally ovate), bluntly acuminate, 0.45-0.8 mm. long, erect-incurved. Setae 10-25 mm. long; capsules 2-2.5 (rarely 3.5) mm. long. Spores 13-18 $\mu$, faintly roughened or minutely papillose.—n = 12, 20, 30.

Breen, Mosses of Florida, Pl. 73 (figs. 5-8). Conard, How to Know the Mosses, (ed. 2) fig. 219a-d. Grout, Mosses with Hand-lens and Microscope, fig. 174 (1a-d), as *Amblystegium irriguum*. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 39, (ed. 2) Pl. 43 (as *H. irriguum*). Welch, Mosses of Indiana, fig. 169 (as *H. irriguum*).—**Fig. 750-752, 753** (*H. fluviatile*), **754** (*H. orthocladon*).




*Leptodictyum trichopodium*. 747. Leaves. 748. Upper cells of leaf. 749. Cells at basal angle.
*Hygroamblystegium tenax*. 750. Habit. 751. Leaves. 752. Upper cells of two leaves.
*Hygroamblystegium "fluviatile."* 753. Leaves
*Hygroamblystegium "orthocladon."* 754. Leaves.
*Hygroamblystegium tenax* var. *spinifolium*. 755. Leaves
*Hygroamblystegium noterophilum*. 756. Leaves.

On wet rocks in and beside brooks, not limited to calcareous habitats. Europe, North Africa, Madeira, and the Caucasus; New Brunswick to Minnesota, south to Arkansas and Florida; Arizona and Mexico.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Carp Creek, Gorge of Carp Creek, Iron Bridge, Burt Lake, Grass Bay, Duncan Bay, Mill Creek. EMMET CO.–Maple River, Wycamp Lake, Wilderness State Park. MACKINAC CO.–Mackinac Island, Cut River. PRESQUE ISLE CO.–Evergreen Beach, Rainy River Falls.

1a. var. **spinifolium** (Schimp.) Jenn.–Slender, yellowish-brown or brown plants with leaves slightly incurved or subsecund when dry, shortly ovate and rather abruptly narrowed to a slender subula largely filled by the excurrent costa.

Grout, Mosses with Hand-lens and Microscope, fig. 174 (1a′), as *Amblystegium irriguum* var. *spinifolium,* Moss Flora of North America 3: Pl. 16 (fig. 4), as *H. irriguum* var. *spinifolium.* Welch, Mosses of Indiana, fig. 170 (as *H. irriguum* var. *spinifolium*).–**Fig. 755.**

Europe; Ontario, Michigan, British Columbia, and Colorado.

CHEBOYGAN CO.–Carp Creek and Gorge of Carp Creek. MACKINAC CO.–Mackinac Island.

*Hygroamblystegium tenax* is relatively soft and slender, with leaves somewhat incurved when dry. Its leaves are broader than those of *Amblystegium varium,* with costa stouter. The var. *spinifolium* has leaves abruptly acuminate, with the costa nearly filling the subula and excurrent.

**Hygroamblystegium fluviatile** (Hedw.) Loeske (fig. 753) is a poor thing scarcely worth segregating from *H. tenax.* At best, it differs in being somewhat larger and in having a somewhat broader costa (about 50-100 $\mu$ wide) which is blackish-green, becoming somewhat brown with age, and upper cells 3-6:1, those at the insertion greenish. *H. tenax,* by contrast, has the costa somewhat narrower, the upper cells 2-3:1, those at the insertion ± yellowish. These differences, by no means absolute, should be viewed in terms of the variability commonly exhibited by aquatic calciphiles.

**Hygroamblystegium orthocladon** (P.-Beauv.) Loeske (fig. 754) is an unimportant form of *H. tenax* with smaller, bluntly pointed leaves.

2. **Hygroamblystegium noterophilum** (Sull. & Lesq. *ex* Sull.) Warnst.–Large, coarse, typically rigid plants in dark-green or brownish mats, often encrusted with lime and often bristly because of persistent costae from which leaf laminae have eroded. Stem and branch leaves similar, rigidly erect (only atypically soft and ± incurved), (1.5)2-3 mm. long, oblong-lanceolate, acuminate; costa very strong (110-140 $\mu$ wide near the base), terete above, excurrent as a stout but mostly short point; upper cells shortly oblong-rhomboidal, 3-5:1, not much differentiated at the insertion. [Only imperfect sporophytes were seen.]

Grout, Moss Flora of North America 3: Pl. 17B.–**Fig. 756.**

Attached to wet, calcareous rocks, usually submerged in running water. New York and Ontario to Minnesota, south to Missouri and Pennsylvania; Chile.

CHEBOYGAN CO.–Nigger Creek. EMMET CO.–Crooked Lake, Ramona Beach. PRESQUE ISLE CO.–Rainy River Falls.

The plants are much larger, coarser, and stiffer than those of *H. tenax* var. *spinifolium,* and the costa is much stouter.

## 5. **Amblystegium** BSG

Plants slender, green, yellowish, or brownish, in dull mats, usually in wet places. Stems creeping, irregularly or subpinnately branched. Leaves small, somewhat concave, erect- to wide-spreading when moist, ovate or lanceolate, gradually or rather abruptly acuminate; margins plane, entire or ± toothed; costa rather slender, ending at or above the leaf middle, sometimes disappearing in the acumen; cells green, thin- or firm-walled, smooth, oblong-rhombic or oblong-hexagonal above, somewhat longer and broader at the base and subquadrate or shortly rectangular in poorly differentiated alar groups. Autoicous; perichaetial leaves erect, pale, lanceolate, acuminate, weakly plicate. Setae elongate, usually reddish; capsules cylindric or oblong-cylindric, curved and inclined, becoming horizontal, arcuate, and constricted below the mouth when dry and empty, smooth; annulus differentiated; operculum conic, acute or apiculate; endostome with cilia nodulose, in groups of 1-3. Spores spherical.—With a blunt lid (or "roof"), referring apparently to the fact that the operculum does not end in a beak. A swampy habitat, slender, arched capsules, lanceolate leaves with a slender costa, and short cells characterize the genus.

Costa disappearing in the acumen; upper cells 2-3:1 — 2. *A. varium*
Costa 1/2-2/3 the leaf length; upper cells 3-5:1 — 1. *A. serpens*

1. **Amblystegium serpens** (Hedw.) BSG—Small plants in loose, soft, green or yellowish mats. Leaves crowded or remote, erect to wide-spreading, 0.5-0.9 mm. long, lanceolate, gradually acuminate, ± serrulate; costa 1/2-2/3 the leaf length; upper cells oblong-rhomboidal, 3-5:1; cells at base broader and subrectangular, a few at the basal margins subquadrate and short-oblong. Setae 9-23 mm. long; capsules 1.5-2 mm. long. Spores 11-18 $\mu$, finely papillose.—n = 7, 10, 10+1, 11, 12, 14, 19, 19+1, 19+2, 20, 22, 40 (and, from experimental material, 24, 28); 2n = 40.

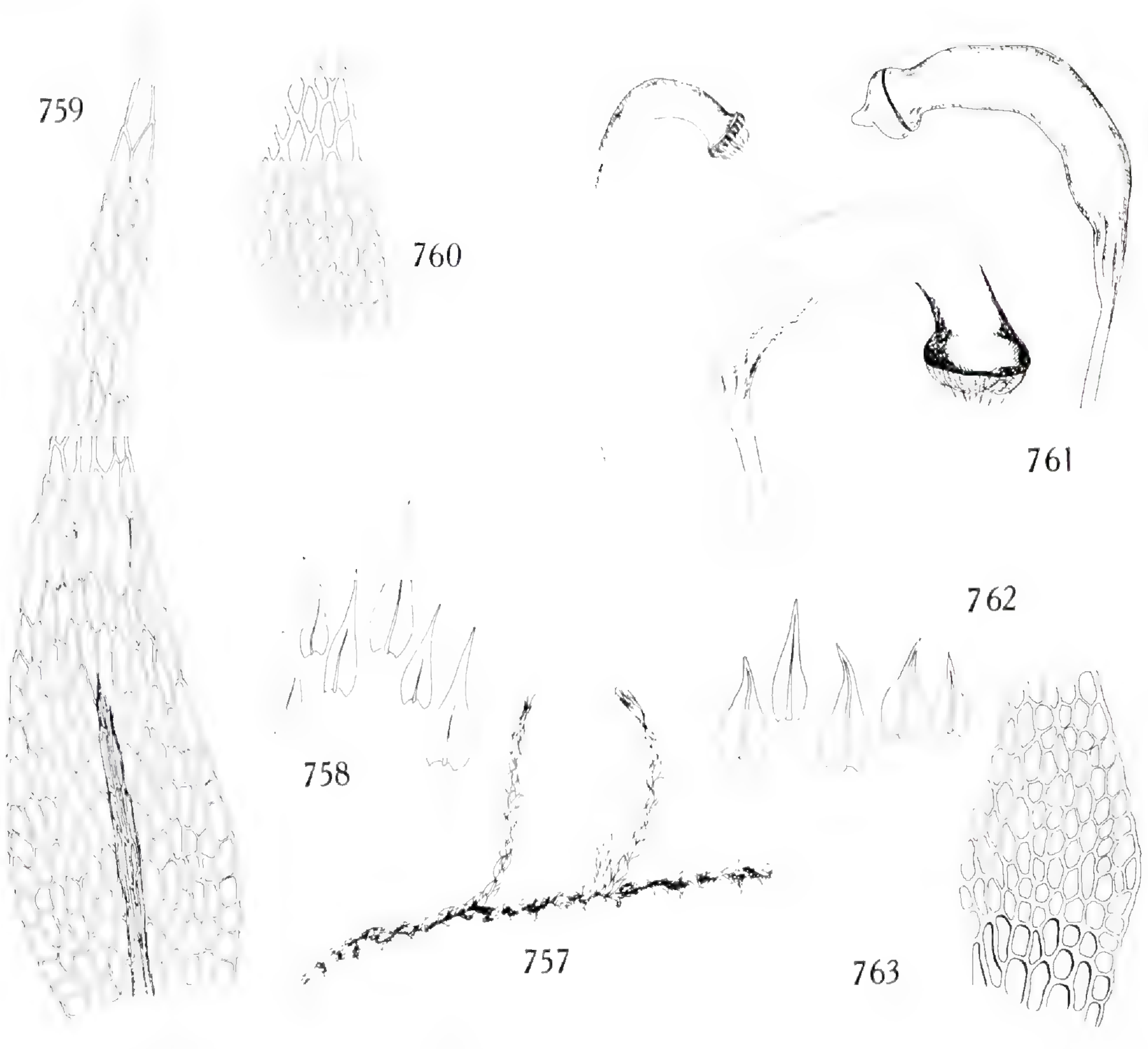
Breen, Mosses of Florida, Pl. 71 (figs. 1-5). Darlington, Mosses of Michigan, fig. 112. Grout, Mosses with Hand-lens and Microscope, fig. 171, Moss Flora of North America 3: Pl. 16 (figs. 11a-b), as *A. juratzkanum.* Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 37 & (ed. 2) Pl. 41 (as *A. serpens* & *A. juratzkanum*). Welch, Mosses of Indiana, fig. 163.—**Fig. 757-761.**

Very common, on wet soil, humus, rotten wood, and other substrata in swampy places. Nearly cosmopolitan; widespread in North America.

CHEBOYGAN CO.—Douglas Lake, Smiths Bog, Reeses Bog, Colonial Point, Riggsville, Grass Bay. EMMET CO.—Arnott Lake, Pellston Hills, Carp Lake, Ellis Township, Cross Village, Middle Village, Five Mile Creek, Big Stone Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island. PRESQUE ISLE CO.—Rainy Lake, Ocqueoc River, Clinton Lake.

The small leaves with short, firm cells and short midrib are distinctive characters. In its more typical form the leaves are more or less erect when dry. In the so-called var. **juratzkanum** (Schimp.) Rau & Herv., which some authors consider a troublesome species (but which I generally ignore), the leaves are wide-spreading wet or dry. (Chromosome counts for the latter include n = 11+1, 12, 12+1, 13, 20.)

2. **Amblystegium varium** (Hedw.) Lindb.—Small plants in loose, yellowish or green, often ± rigid mats. Stem leaves often considerably longer and broader than the branch leaves, about 0.6-1.2 mm. long, ovate-lanceolate, somewhat decurrent, with costa stronger and more nearly percurrent, about 22-33 $\mu$ wide near the base. Branch leaves loosely erect and usually slightly incurved when dry, spreading or erect-spreading when moist, very variable in size and shape, about 0.35-0.7 mm. long, lanceolate, gradually and slenderly acuminate; margins entire or slightly serrulate; costa disappear-




*Amblystegium serpens.* 757. Habit. 758. Leaves. 759. Cells of branch leaf. 760. Upper cells of branch leaf (shorter and more typical). 761. Capsules.
*Amblystegium varium.* 762. Leaves. 763. Alar cells.

ing in the acumen, often flexuose above, about 17-26 $\mu$ wide near the base; upper cells oblong-rhombic, about 2-3:1; lower cells shortly oblong-hexagonal, a few at the basal angles subquadrate. Setae 12-22 mm. long; capsules 1.2-2 mm. long; cilia 1-3. Spores 9-14 $\mu$, minutely papillose.—n = 10, 12+1, 19+1, 20, 22.

Grout, Mosses with Hand-lens and Microscope, Pl. 78 & fig. 175(2). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 37, (ed. 2) Pl. 41. Welch, Mosses of Indiana, fig. 165.—**Fig. 762-763.**

On soil, humus, logs, rocks, and other substrata, in wet, shady places. Circumpolar; widespread in North America; Mexico; Haiti.

CHEBOYGAN CO.–Polypody Bluff (Douglas Lake), Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Smiths Bog, Colonial Point, Ingleside, Black Lake. EMMET CO.–Five Mile Creek, Pellston Hills. MACKINAC CO.–Gros Cap, Caffey Corner. PRESQUE ISLE CO.–Near Belknap, Clinton Lake.

As the name suggests, this is a variable and troublesome species. The plants are somewhat larger than those of *A. serpens.* The main character is the long costa which disappears in the narrow acumen. The basal cells of the leaf are typically dark and somewhat enlarged. The species approaches *Hygroamblystegium tenax,* but the leaves are softer and narrower and the costa considerably narrower. The habitat of *H. tenax* on wet rocks (and commonly submerged) is, of course, distinctive.

## 6. **Drepanocladus** (C. M.) Roth

Plants generally rather robust, in extensive mats or deep tufts, green, yellow-green, golden or brownish, sometimes red, often ± glossy, mostly growing in wet places, sometimes submerged. Stems creeping or erect-ascending, freely and irregularly to pinnately branched, or rarely nearly simple; paraphyllia few, at branch bases. Leaves nearly always falcate-secund, ± concave, sometimes striate or plicate, lanceolate or ovate-lanceolate, slenderly long-acuminate, frequently ± auriculate at base; margins erect, entire or ± serrulate; costa single, ending near the leaf middle or in the acumen, sometimes excurrent; cells mostly long-linear, smooth, sometimes thick-walled and porose at base or throughout, usually differentiated at the basal angles, sometimes in well-marked, excavate groups extending nearly to the costa, hyaline, thin-walled, and inflated or sometimes colored and thick-walled. Perichaetial leaves erect, lanceolate, slenderly long-acuminate, mostly plicate. Capsules ± curved, usually strongly so; annulus mostly differentiated; operculum apiculate; endostome with often perforate segments and nodulose cilia in groups of 1-4.—The name refers to the falcate-secund leaves which give the branch tips a hooked, sickle-like appearance. This is a genus of mostly aquatic and subaquatic species, varying chaotically with seasonal fluctuations in water level and associated changes in salinity and hydrogen-ion concentration.

1. Leaves plicate or striolate when dry
  2. Leaves plicate, with a few enlarged, hyaline alar cells; cortical cells large, hyaline, thin-walled — 1. *D. uncinatus*
  2. Leaves merely striolate when dry, without enlarged alar or cortical cells — 3. *D. vernicosus*
1. Leaves smooth or (if striolate when dry, the alar cells conspicuously inflated)
  3. Leaves entire
    4. Alar cells not or very slightly differentiated — 2. *D. revolvens*
    4. Alar cells inflated, in large and conspicuous groups
      5. Cells of leaf base clearly elongate, oblong or oblong-linear — 4. *D. aduncus*
      5. Cells of leaf base shortly oblong or oblong-hexagonal — 4a. *D. aduncus* var. *polycarpus*
  3. Leaves serrulate, at least at the apex
    6. Leaves relatively flat, often striolate when dry; costa rather broad, usually extending well into the acumen; alar cells abruptly inflated, in large, decurrent auricles usually reaching the costa; dioicous — 5. *D. exannulatus*
    6. Leaves concave, smooth; costa narrow, ending well above the midleaf; alar cells often somewhat enlarged but not abruptly differentiated, not in decurrent auricles; autoicous — 6. *D. fluitans*

1. **Drepanocladus uncinatus** (Hedw.) Warnst.—Plants rather slender to fairly robust, in loose, yellow, brownish, or green, somewhat shiny mats or tufts. Stems creeping to more crowded and erect or ascending, irregularly to subpinnately branched; cortical cells large and hyaline. Leaves strongly falcate-secund, 2.5-4 mm. long, gradually long-subulate from a lanceolate base, not decurrent, slightly to strongly plicate (especially when dry), remotely serrulate toward the apex; costa ending above the middle or in the acumen; upper cells linear-flexuose, those at the insertion oblong, thick-walled and porose, the alar cells oblong-hexagonal, hyaline, and thin-walled in small, inconspicuous alar groups. Autoicous; perichaetial leaves greatly elongate (4-8 mm. long), ± plicate. Setae 15-32 mm. long; capsules 1.7-3 mm. long; annulus present; cilia of endostome 1-3. Spores 10-16 $\mu$, very finely papillose.—n = 9+1, 10, 11, 12, 20.

Conard, How to Know the Mosses, (ed. 2) fig. 210a-d. Grout, Mosses with Hand-lens and Microscope, Pl. 72.—**Fig. 764-766.**

On rocks, decaying wood, humus, or bark at base of trees in moist or dry, coniferous forests. Nearly cosmopolitan; Greenland to Alaska, south to California, Arizona, New Mexico, Ohio, and Pennsylvania.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Burt Lake, Grass Bay. EMMET CO.–Arnott Lake, Pleasantview Swamp, Cecil Bay. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, Cut River, Epoufette, Ozark. PRESQUE ISLE CO.–Mast Point, Lamprey Experiment Station, Evergreen Beach.

Unlike other members of the genus, *D. uncinatus* grows in relatively dry niches (such as on logs) in dry or moist, coniferous forests. It can be quite beautiful, with golden or green, glossy leaves which are circinately secund and deeply plicate, not unlike those of *Ptilium*. It is variable, however, and often scraggly in appearance. A common expression is the so-called var. **plumulosus** (BSG) Warnst., which is more slender, with leaves not or only slightly striate and nearly entire. The var. **symmetricus** (Ren. & Card.) Grout has capsules small, erect, symmetric, and cylindric; its leaves are less strongly plicate than in the typical variety and entire or slightly denticulate. (It has been collected in the Lake Superior region of Ontario.)

2. **Drepanocladus revolvens** (Sw.) Warnst.–Rather robust plants in dense, glossy, typically reddish to blackish-purple tufts, sometimes green, yellow, or brownish (with or without red tinges). Stems erect or ascending, irregularly to subpinnately branched; central strand present but very small and inconspicuous, consisting of 3-4 small cells; outer cells of stems and branches hyaline and thin-walled (usually remaining attached to the bases of leaves stripped off for examination and obviously broader than leaf cells). Leaves usually crowded, strongly falcate-secund with flexuose tips, smooth (or very rarely and very slightly striolate) when dry, 3-4 mm. long, concave, lanceolate or ovate-lanceolate, gradually narrowed to a long, filiform, flexuose point; margins erect, entire; costa slender, about ¾ the leaf length; cells long-linear, flexuose, with thick walls, a few rows at the insertion oblong-linear and somewhat darker with thick, ± porose walls, at the basal angles a few, hyaline, slightly enlarged cells. Autoicous. Setae 30-55 mm. long; capsules 2-3 mm. long; annulus present; cilia of endostome in groups of 1-3. Spores 13-18 $\mu$, finely papillose.–n = 10+1, 20, 22+1, 23.

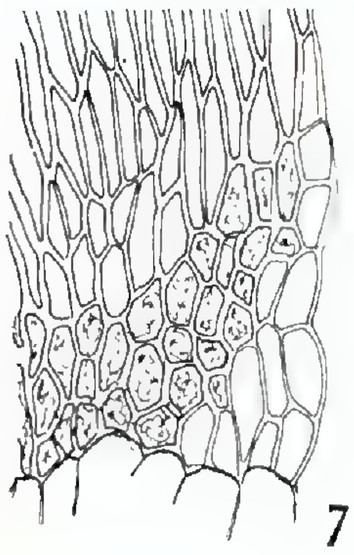
Darlington, Mosses of Michigan, fig. 120. Grout, Mosses with Hand-lens and Microscope, Pl. 71, Moss Flora of North America 3: Pl. 28B.–**Fig. 767-768.**

On wet soil in swampy places, near springs, margins of lakes, etc., apparently most common in alkaline bogs. Circumpolar; Colombia; New Guinea; Alaska and British Columbia, across the continent and south to Michigan, Quebec, and Nova Scotia.

CHEBOYGAN CO.–Little Lake 16. EMMET CO.–Cecil Bay, Big Stone Bay. MACKINAC CO.–Bois Blanc Island.

The plants are a beautiful purplish-red, with long, flexuose, circinate leaf tips. The basal cells are incrassate and porose and contrast with the large, hyaline cortical cells which generally strip off with the leaves on dissection. A few alar cells are often hyaline and somewhat enlarged.–Locally rare, perhaps limited to more acid situations.

Var. **intermedius** (Lindb. *ex* C. J. Hartm.) Rich. & Wall.–Plants yellow-brown. Leaves with shorter acumina, not or rarely somewhat striolate. Cortical cells of stem enlarged; cells across insertion of leaf not much differentiated, a few alar cells hyaline and somewhat inflated (though inconspicuous). Locally common in rich (calcareous) fens. It occupies the same habitats as *D. vernicosus* and looks like it too. I have trouble finding any characters separating them. I believe that *D. revolvens* var. *intermedius* is only an expression of *D. vernicosus*, but without further study I lack the courage to flout tradition. (The fact that *D. revolvens* is acid-loving also makes me wonder if such a calciphile as the so-called var. *intermedius* is genetically allied to it.) Circumpolar; common in more northerly latitudes of North America.



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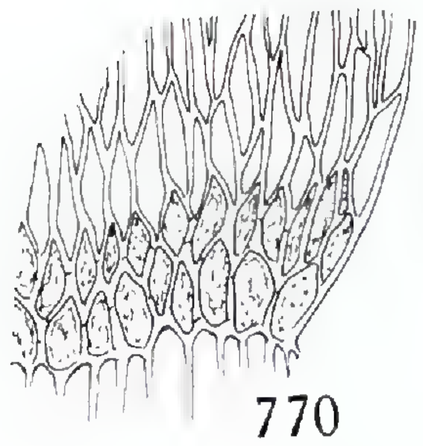

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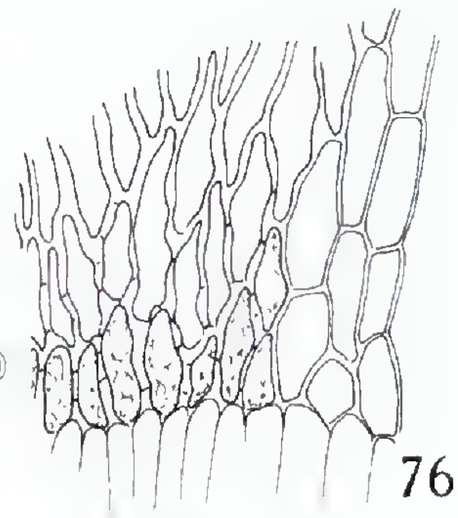

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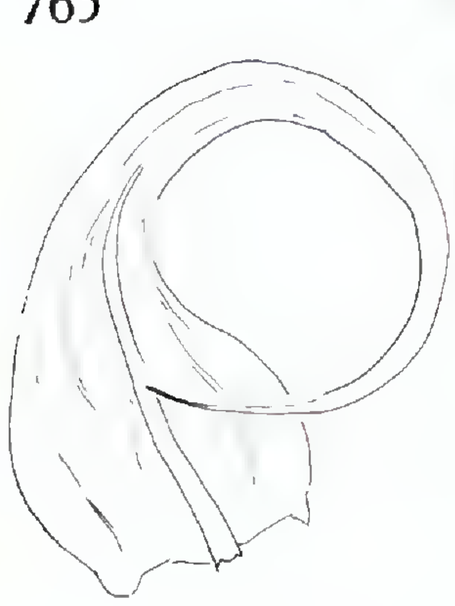

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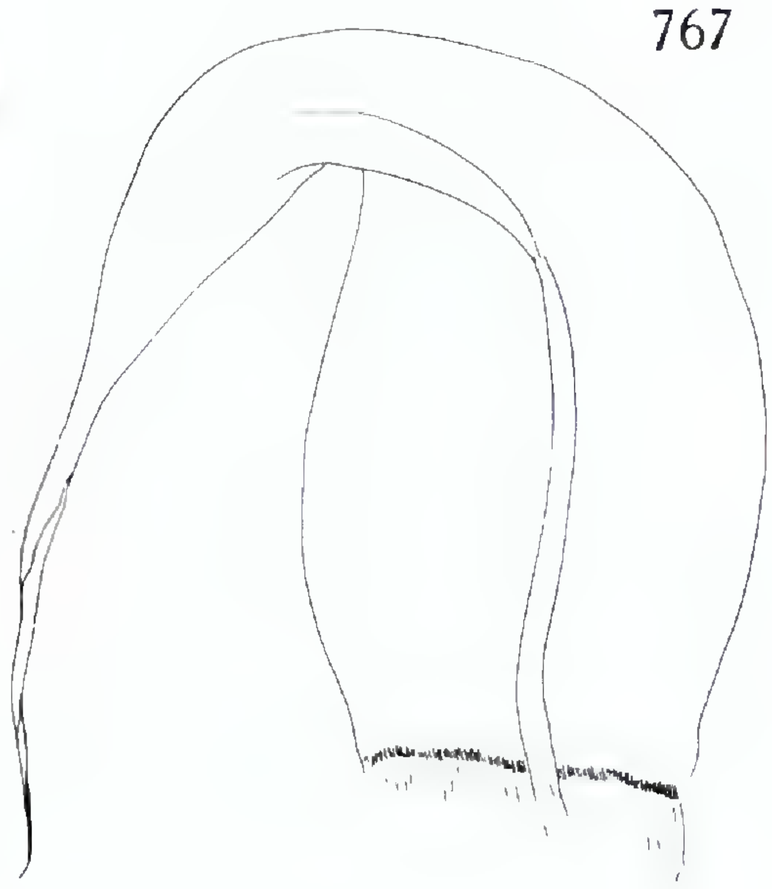

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*Drepanocladus uncinatus.* 764. Habit. 765. Leaf. 766. Alar cells.
*Drepanocladus revolvens.* 767. Leaf. 768. Alar cells.
*Drepanocladus vernicosus.* 769. Leaves. 770. Alar cells.

3. **Drepanocladus vernicosus** (Lindb. *ex* C. J. Hartm.) Warnst.—Plants in green or yellowish, sometimes brownish, rarely reddish tufts. Stems erect-ascending, ± pinnately branched; central strand none; cortical cells not large (not often remaining attached to leaves stripped from the stems and not obviously broader than leaf cells). Leaves usually not crowded, ± striolate when dry, falcate-secund, 1.5-2 mm. long, lanceolate to ovate-lanceolate, gradually narrowed to a relatively short or sometimes long, slender, flexuose-twisted acumen, entire; costa ending somewhat above the leaf middle; upper cells linear-flexuose; basal cells shorter, more incrassate, porose, and colored in about 2 rows at the leaf insertion, a few at the basal angles occasionally pale and slightly differentiated. Dioicous. Setae 35-65 mm. long; capsules 2-3.5 mm. long; annulus of 2-3 rows of cells; cilia in 2's and 3's. Spores 12-22 $\mu$, nearly smooth to finely papillose.

Grout, Mosses with Hand-lens and Microscope, fig. 160 and Pl. 71. Welch, Mosses of Indiana, fig. 182.–**Fig. 769-770.**

On wet soil or humus in calcareous fens. Circumpolar; Greenland to Alaska, south to Oregon, Iowa, Ohio, and Pennsylvania.

CHEBOYGAN CO.–Reeses Bog, Douglas Lake, Grass Bay. EMMET CO.–Cecil Bay, Big Stone Bay, Lawrence Lake, Conway, Bear Creek Township. MACKINAC CO.–Mackinac Island, Bois Blanc Island, Mud Lake, Rexton. PRESQUE ISLE CO.–Mast Point, Hammond Bay, Evergreen Beach, Ocqueoc Lake, Kelsey Pond, Clinton Lake.

The leaves are finely striate when dry. The cortical cells are not large and hyaline, as in *D. revolvens* var. *intermedius,* but the extreme basal cells may be hyaline in a single row. Above them are one or sometimes two rows of thick-walled cells forming a darker line across the leaf. *D. revolvens* var. *intermedius* is similar, but the cells across the insertion may be less clearly differentiated, the cortical cells enlarged, and a few alar cells hyaline and somewhat inflated. As stated above, I have grave doubts of any genetic difference, regardless of characters which in some specimens allow pigeonholing.

4. **Drepanocladus aduncus** (Hedw.) Warnst.–Rather robust plants in soft, loose or dense, dark- to yellow-green or brownish mats or tufts. Stems spreading or more crowded and suberect, irregularly to pinnately branched. Leaves falcate-secund, not plicate or striolate when dry, ovate-lanceolate and gradually narrowed to a short or long, channeled acumen, entire; costa narrow or stout, ending at or above the leaf middle; cells linear-flexuose above, those at base long-rhomboidal, not or somewhat porose, the alar cells clearly differentiated, yellow-brown or hyaline, thin- or rather thick-walled, and inflated in large, non-decurrent, auriculate groups scarcely extending to the costa. Dioicous. Setae about 2.5 cm. long; capsules 2-2.5 mm. long; annulus present. Spores about 16 $\mu$, papillose.–n = 12, 20 (as *D. kneiffii*).

Conard, How to Know the Mosses, (ed. 2) fig. 202a, d. Grout, Mosses with Hand-lens and Microscope, Pl. 74 (fig. 1), also fig. 163b, Moss Flora of North America 3: Pl. 24D, 27A (figs. a-b). Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 67. Welch, Mosses of Indiana, fig. 183.–**Fig. 771-772.**

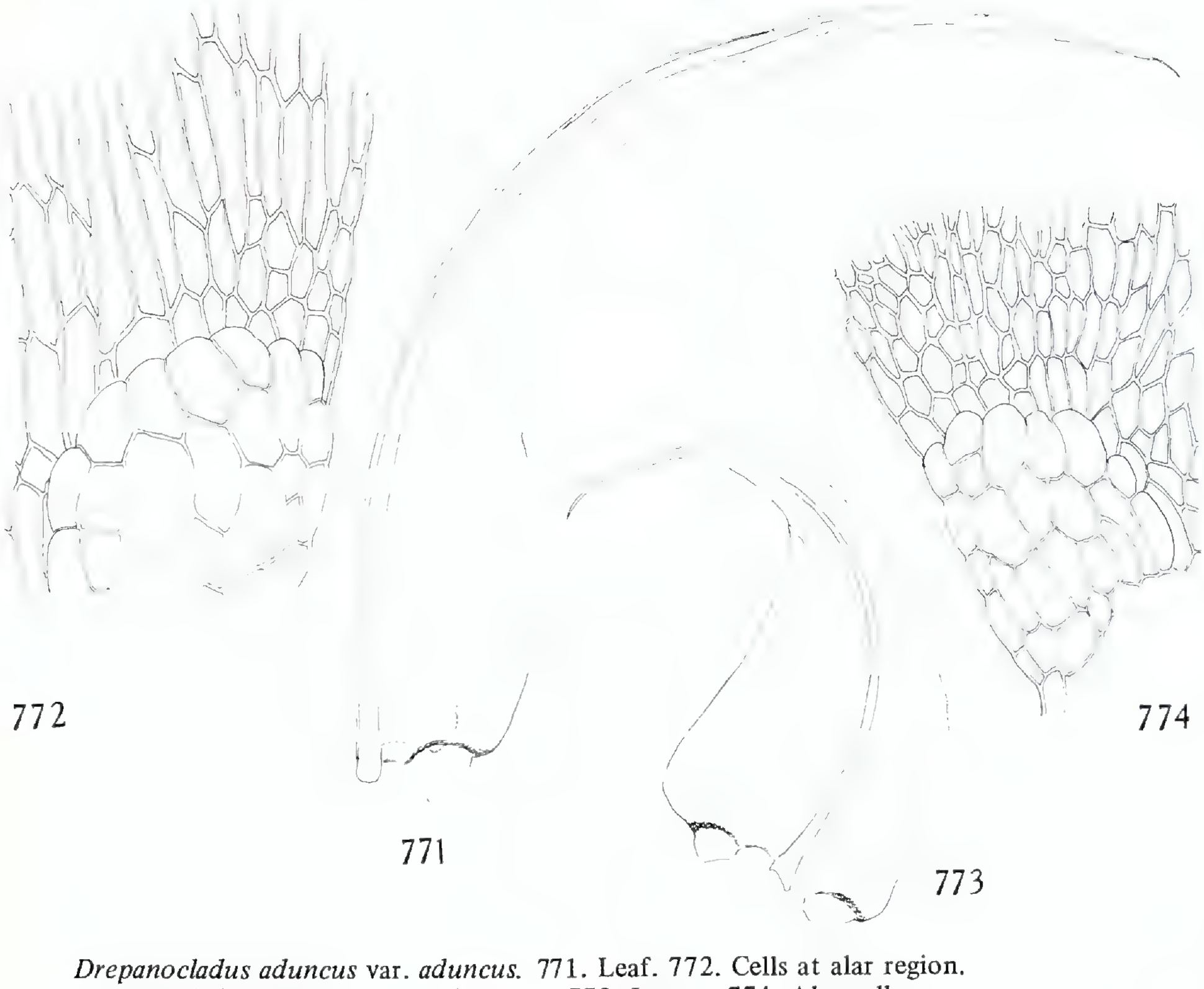
On soil in wet, often calcareous habitats (swamps, meadows, boggy woods), frequently submerged or emergent, at least during high water, in the shallow water of pools, springs, and ditches. Circumpolar; Mexico, Peru, Australia, New Zealand, Kerguelen; widespread in North America, especially common in the North.

CHEBOYGAN CO.–Hermits Bog, Reeses Bog, Gorge of Carp Creek, Burt Lake, Douglas Lake, Ingleside, Bryants Bog, Smiths Bog, Passino School, Lancaster Lake, near Mackinaw City, Duncan Bay, Black Lake, Indian River. EMMET CO.–Levering, Arnott Lake, Crooked River, Carp Lake, Cecil Bay, Wilderness State Park. MACKINAC CO.–Bois Blanc Island, Mackinac Island, Peggley Lake. PRESQUE ISLE CO.–Mast Point, Grace Harbor.

4a. Var. **polycarpus** (Bland. *ex* Voit) Roth–Leaves slightly to strongly falcate-secund, broadly oblong-ovate, usually rather shortly acuminate; cells of the leaf base shortly oblong or oblong-hexagonal, the alar cells in ± decurrent auricles extending nearly to the costa.

Grout, Mosses with Hand-lens and Microscope, Pl. 74 (fig. 2), Pl. 74 (figs. 10-11), as fo. *gracilescens,* Moss Flora of North America 3: Pl. 26D & 27A (fig. i), Pl. 27A (figs. k-l) & 28A (as fo. *gracilescens*). Welch, Mosses of Indiana, fig. 186.–**Fig. 773-774.**

A plant of wet, calcareous habitats, sometimes submerged. Nearly cosmopolitan; throughout arctic America and south to Pennsylvania, Missouri, New Mexico, and California.




*Drepanocladus aduncus* var. *aduncus*. 771. Leaf. 772. Cells at alar region.
*Drepanocladus aduncus* var. *polycarpus*. 773. Leaves. 774. Alar cells.

CHEBOYGAN CO.–Reeses Bog, Gorge of Carp Creek, Burt Lake, Linné Bog, Mud Lake, Munro Lake, Lancaster Lake, Black Lake, Black River, Duncan Bay. EMMET CO.–Maple River, Carp Lake, Arnott Lake, Alanson. MACKINAC CO.–Bois Blanc Island. PRESQUE ISLE CO.–Grace Harbor, Ocqueoc Falls.

*Drepanocladus aduncus* is very common and exceedingly variable. It is usually soft and green to yellow or brown, with leaves not crowded, moderately falcate, and not plicate, with alar cells clearly differentiated in large groups. The entire leaf margins provide a quick means of separation from *D. fluitans* and *D. exannulatus*. The typical variety has long basal cells, whereas those of the var. *polycarpus* are short. The var. **polycarpus** fo. **gracilescens** (BSG) Mönk. has been collected at Duncan Bay in Cheboygan County; it is an unusually slender form of little significance. The var. **kneiffii** (BSG) Mönk. is a common form with leaves more or less remote and not or only slightly falcate; I see no good reason to bother with it. Finally, **D. sendtneri** (Schimp.) Warnst. has alar cells usually orange-colored and rather thick-walled in fairly distinct groups and with a stronger costa; I include it here as a probable ecological expression, although I am not sure of its taxonomic limits or ecological preferences. (It has been collected in Cheboygan and Delta Counties and is probably common elsewhere in especially calcareous habitats.) A number of local collections qualify as var. **aduncus** fo. **capillifolius** (Warnst.) Mönk., a robust, generally submerged form with straight or ± curved leaves with long, slender acumina and long, often excurrent costa; both var. *aduncus* and var. *polycarpus* apparently produce such *capillifolius* forms.

**Calliergidium pseudostramineum** (C. M.) Grout, which bears some resemblance to *Drepanocladus* and *Calliergon*, has been found in Delta County. The leaves, crowded

and more or less imbricate, are striolate when dry, ovate or ovate-lanceolate and broadly tapered to a narrow, rounded point; the margins are entire and the alar cells abruptly inflated.

5. **Drepanocladus exannulatus** (BSG) Warnst.—Plants green or yellow-brown, sometimes red-tinged to purple-red, up to 25 cm. long. Stems ± pinnately branched. Leaves twisted and striate when dry, somewhat to strongly falcate-secund, 2-5 mm. long, lanceolate and gradually long- to filiform-acuminate, the apex sometimes subobtuse; margins plane, subentire or more often ± serrulate, sometimes nearly to the base; costa rather broad, extending well into the acumen, sometimes ending near the apex; upper cells linear; alar cells hyaline, thin-walled, and conspicuously inflated in auriculate groups extending nearly to the costa. Dioicous. Setae 30-75 mm. long; capsules 2.2-3 mm. long; annulus none; cilia in groups of 2 or 3. Spores 15-24 $\mu$, very finely papillose.—n = 11, 12.

Conard, How to Know the Mosses, (ed. 2) fig. 203. Grout, Mosses with Hand-lens and Microscope, Pl. 74 (figs. 7, 8, 16), Moss Flora of North America 3: Pl. 29B, C. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 40, (ed. 2) Pl. 44. Welch, Mosses of Indiana, fig. 189.—**Fig. 775-777.**

In wet places, sometimes submerged. Circumpolar; Colombia; Greenland to Alaska and south to California, Colorado, Michigan, and Pennsylvania.

CHEBOYGAN CO.—Livingston Bog, Smiths Bog, Vincent Lake, Mud Lake, Little Lake 16. EMMET CO.—Sherett Lake, Stutsmanville. MACKINAC CO.—Little Dollar Lake.

As compared with *D. fluitans,* this species is more pinnately branched and often purplish, with leaves more or less flat and often finely striate when dry and alar cells in large, abruptly differentiated, excavate groups. The serrulate leaf margins alone will distinguish it from the myriad forms of *D. aduncus.*

*Drepanocladus exannulatus,* like other mosses of wet or aquatic habitats, varies endlessly with conditions of environment. The taxonomic implications of such variations are beautifully illustrated by Smirnova's transplant studies, summarized in English by Lodge (Trans. Brit. Bryol. Soc. 2(4): 575-577. 1955). According to her findings, the var. *rotae* (De Not.) Loeske is merely a submerged form of the species. In dryer than normal conditions, a short-leaved and short-celled var. *alpinus* (Grav.) Wijk & Marg., also known as the fo. *brachydictyus* (Ren.) Smirn., develops. With good aeration and high light intensity, this form becomes purple and may be called the var. *purpurascens* Schimp. On extreme exposure, the fo. *tundrae* (Arn.) Mönk., often recognized at the specific level as *D. tundrae* (Arn.) Loeske, results.

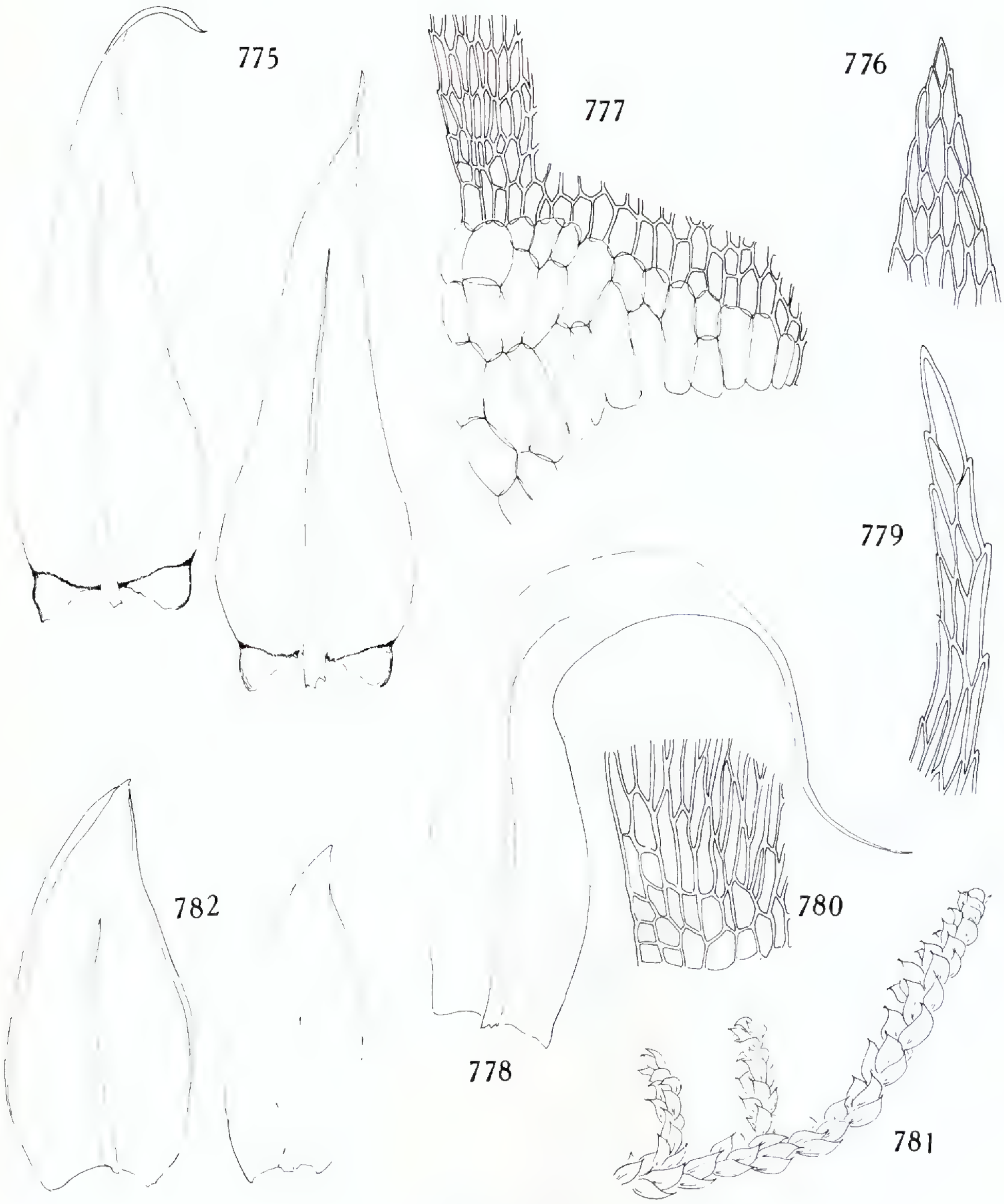
Lodge (Jour. Linn. Soc. London, Bot. 56: 218-224. 1959) found by varying environmental conditions in culture that growth forms of *D. exannulatus* and *D. fluitans* could be greatly altered, whereas certain structural details, such as the nature of the alar cells, remained relatively unchanged.

Sonesson (Bot. Notis. 119: 379-400. 1966) grew *Drepanocladus trichophyllus* (Warnst.) Podp. (a relative of *D. exannulatus* with a long excurrent costa) from spores and reported that "four different morphological categories are possible to distinguish in the progeny."

6. **Drepanocladus fluitans** (Hedw.) Warnst.—Plants in loose, green, yellow-green, or brown, shiny masses. Stems sparsely branched. Leaves rather distant, falcate-secund, at least at the tips of stems and branches, 3-4 mm. long, oblong-lanceolate, gradually narrowed to a long, flexuose acumen, somewhat narrowed to the base, not or only

slightly decurrent, serrulate at the apex; costa slender, ending well above the midleaf; cells linear-flexuose; alar cells oblong, hyaline or colored, usually somewhat enlarged, occasionally inflated but not forming auricles. Autoicous. Setae 50-75 mm. long; capsules about 2-3 mm. long; annulus none. Spores 17-27 $\mu$, finely papillose.—n = 20, 22, 22+2, 24; also 20 (as var. *falcatus*).

Grout, Mosses with Hand-lens and Microscope, Pl. 73, also fig. 163a, Moss Flora of North America 3: Pl. 29A. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 69. Welch, Mosses of Indiana, fig. 188.—**Fig. 778-780.**




*Drepanocladus exannulatus.* 775. Leaves. 776. Cells at leaf tip. 777. Alar cells.
*Drepanocladus fluitans.* 778. Leaf. 779. Cells at leaf tip. 780. Alar cells.
*Hygrohypnum luridum.* 781. Habit. 782. Leaves.

On wet soil of ditches, swamps, bogs, meadows, swales, or lake margins, often submerged. Nearly cosmopolitan; widespread in northern latitudes of North America, south to California, Colorado, Michigan, and West Virginia.

CHEBOYGAN CO.–Reeses Bog, Gleasons Bog, Bryants Bog, Livingston Bog, Mud Lake. EMMET CO.–Sherett Lake, Gladys Bog, Stutsmanville. MACKINAC CO.–Rexton.

In contrast to *D. exannulatus, D. fluitans* is softer, shinier, and often brownish or reddish but never wine-red or purple. The leaves, not striate, are scarcely narrowed to the base; the alar cells are sometimes slightly inflated but usually not abruptly differentiated and not occupying excavate groups. Williams (Bryol. 33: 32. 1930) reported this species from a depth of 62 feet in a lake in northern Wisconsin.

**Drepanocladus fluitans** var. **uncatus** Crum, Steere & Anders., generally known as the var. *falcatus* (C. Jens.) Roth and sometimes as *D. schulzei* Roth, is a rather common form of the species with alar cells slightly more differentiated than usual.

## 7. **Hygrohypnum** Lindb.

Plants slender to moderately robust, in green, yellow, or red-gold, ± shiny, dense mats. Stems creeping, irregularly branched; paraphyllia few, at the branch bases; paraphysis-like hairs often in leaf axils. Leaves imbricate to spreading, often secund, concave (sometimes strongly so and ± cucullate at the apex), smooth or weakly plicate, oblong-lanceolate and acuminate or broadly oblong-ovate to subcircular and blunt or rounded at the apex; margins erect, sometimes incurved toward the apex, entire or serrulate; costa often variable on the same plants, generally unequally forked and usually short and weak, rarely single and nearly percurrent; cells smooth, oblong-linear or linear-flexuose, often short and oblong-rhombic at the extreme apex, generally yellow or orange at the middle of the insertion, the alar cells subquadrate or oblong, hyaline or colored, sometimes clearly inflated in small, well-marked alar groups. Perichaetial leaves erect, elongate, generally plicate. Capsules ovoid or oblong-cylindric, ± curved; annulus present; operculum sometimes rostrate; endostome with perforate segments and ± nodose cilia (rarely lacking or rudimentary).–A "*Hypnum*" of wet habitats. The very concave leaves and variable costa are characteristic features of the genus, as well as the occurrence on wet rocks.

**Hygrohypnum luridum** (Hedw.) Jenn.–Plants of medium size, in dark- or yellow-green to brownish, loose or dense mats. Leaves crowded, erect or, more often, secund, 1-1.5 mm. long, concave, broadly to narrowly oblong-ovate, obtuse or acute, sometimes apiculate; margins erect or incurved above, entire; costa variable even on the same plants, yellowish, single, and 1/2-2/3 the leaf length, sometimes short and double or forked; upper cells linear-flexuose; alar cells rather numerous, small, subquadrate, opaque. Autoicous. Setae 13-20 mm. long; capsules about 2.5 mm. long; cilia 1-3. Spores 15-18 $\mu$, finely papillose so nearly smooth.–n = 10, 10+1, 11, 12+1.

Conard, How to Know the Mosses, (ed. 2) fig. 273e. Darlington, Mosses of Michigan, fig. 116. Grout, Moss Flora of North America 3: Pl. 23 upper & lower right, lower left (as *H. palustre,* var. *subsphaericum,* & var. *julaceum*).–**Fig. 781-782.**

On wet rocks in and beside streams (especially common in cascading brooks and near waterfalls); probably a calciphile. Circumpolar; widespread in North America, across the continent and south in the mountains to Colorado, in the East to Pennsylvania.

CHEBOYGAN CO.–South of Burt Lake, Mill Creek. PRESQUE ISLE CO.–Ocqueoc Falls.

The leaves may be distinctly secund or erect and imbricate, but in spite of considerable variability, the deeply concave, entire leaves with alar cells few and small and costa variable, coupled with the subaquatic habitat, are useful differentia. Braithwaite expressed the variability well when he said, "So polymorphous is this species that a long series of varieties might be set up, without much benefit, as they do not appear to maintain their stability, and even two forms of nerve may be found in leaves from the same plant." The species is locally rare enough not to cause too much trouble.

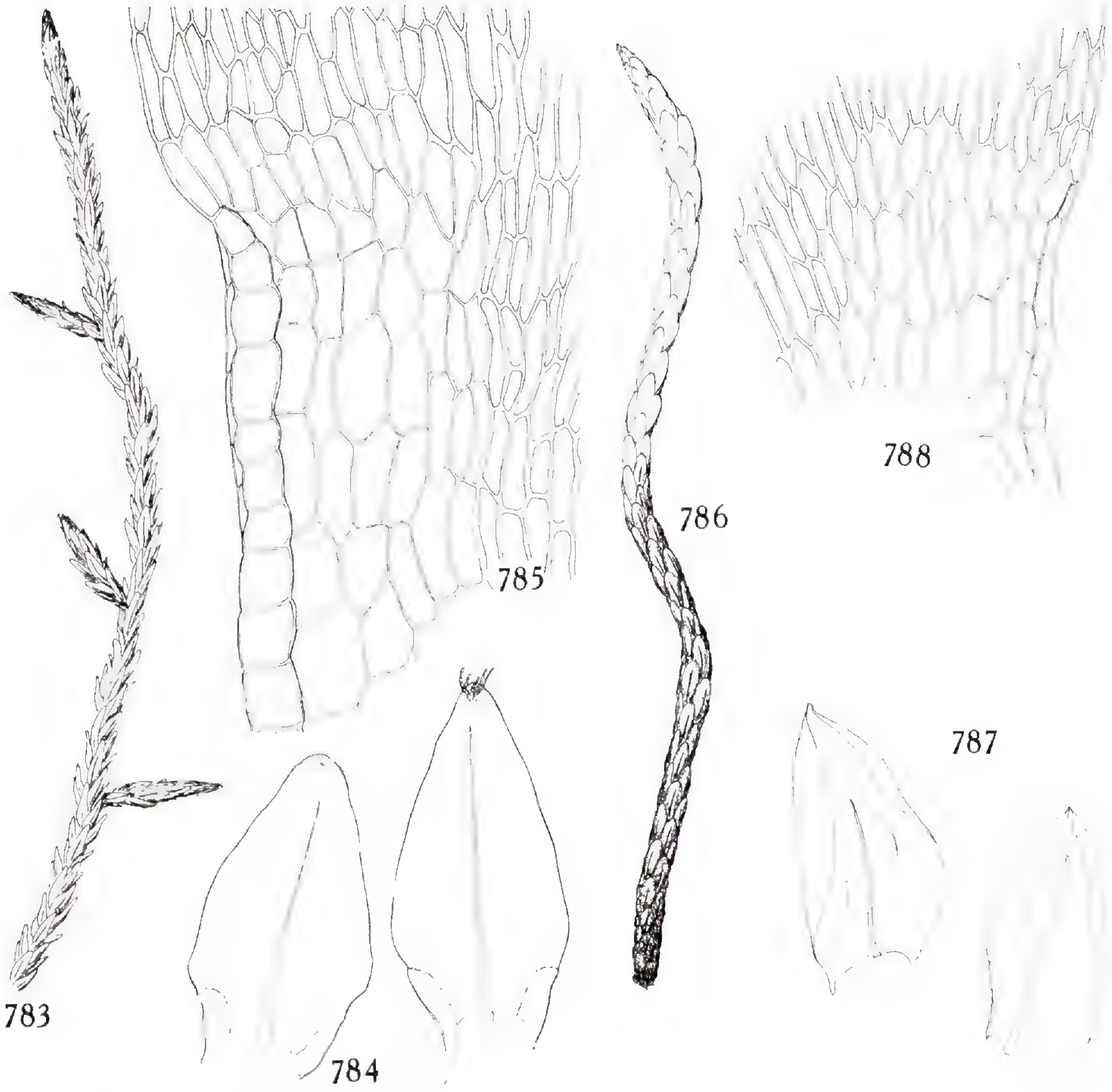
In the Upper Peninsula we have two other species: **H. ochraceum** (Turn. *ex* Wils.) Loeske has loosely falcate-secund leaves and large hyaline alar cells and similarly enlarged cortical cells. It resembles *Hypnum lindbergii* but has a much stronger costa, one-half or more the leaf length. The chromosome number has been recorded as n = 10, 11. **H. molle** (Hedw.) Loeske has leaves spreading from an erect base.

## 8. **Calliergon** (Sull.) Kindb.

Plants relatively robust, in deep, loose tufts, green or yellowish to red-brown or purplish, sometimes ± shiny. Stems erect or ascending, sparsely to freely and sometimes pinnately branched; branches cuspidate at the tips because of crowded, erect leaves; paraphyllia few, at branch bases. Stem leaves large, imbricate to erect-spreading, ± concave, often cucullate at the apex, rarely somewhat striate, oblong- to rounded-ovate or suborbicular, broadly rounded and sometimes apiculate at the apex, often producing radicles at back near the apex from scattered, pellucid cells; costa mostly rather strong, single, extending somewhat beyond the leaf middle or nearly to the apex, sometimes forked at the tip; cells smooth, linear-rhomboidal, shorter toward the base, subquadrate or hexagonal and inflated in usually well-marked, concave alar groups, rarely slightly differentiated at the basal angles. Branch leaves smaller, narrower, and often subtubulose above. Perichaetial leaves erect, ± long-acuminate, not plicate. Capsules oblong-cylindric to oblong-ovoid, mostly strongly curved; annulus present or lacking; operculum blunt or acute; endostome with sometimes perforate segments and delicate, sometimes nodose cilia in 2's to 4's.—The name, meaning pretty work, refers to good workmanship or elegance in construction or appearance.

1. Plants usually dark and brownish, terete when dry, turgid when moist; alar cells not much differentiated — 2. *C. trifarium*
1. Plants usually pale and yellowish or greenish, ± cuspidate at tips of stems and branches but not otherwise terete or turgid; alar cells inflated in large, gradually or abruptly differentiated groups
 2. Plants relatively slender; leaves oblong or oblong-ovate — 1. *C. stramineum*
 2. Plants coarser and fairly robust; leaves broad, cordate-ovate
  3. Plants sparsely and irregularly branched; inflated alar cells gradually differentiated — 5. *C. cordifolium*
  3. Plants pinnately branched; inflated alar cells abruptly differentiated
   4. Dioicous; costa ending near the apex — 3. *C. giganteum*
   4. Autoicous; costa ½-¾ the leaf length — 4. *C. richardsonii*

1. **Calliergon stramineum** (Brid.) Kindb.—Relatively slender plants in deep, loose or dense, somewhat shiny, green or more often yellowish to straw-colored masses. Stems 5-12 cm. high (or rarely as much as 30 cm.), sparsely branched, erect-ascending, slenderly terete toward the apex and cuspidate-tipped because of crowded, imbricate leaves. Stem leaves somewhat crowded, erect-spreading below, erect or imbricate above when dry and erect or erect-spreading when moist, 1.2-2 mm. long, oblong or oblong-ovate, rounded and cucullate at the apex, often radiculose near the tips,




*Calliergon stramineum.* 783. Habit. 784. Leaves. 785. Alar cells.
*Calliergon trifarium.* 786. Habit. 787. Leaves. 788. Alar cells.

decurrent, entire; costa 3/4-5/6 the leaf length; cells at extreme apex shortly oblong or rhombic; upper median cells linear, becoming shorter and broader near the base, inflated in fairly large but not sharply delimited, decurrent, hyaline alar groups (often orange-yellow within). Dioicous. Setae 35-45 mm. long, red-yellow or red; capsules about 2 mm. long; annulus none; operculum apiculate; segments of endostome narrowly perforate; cilia 1-2. Spores 13-15 $\mu$, finely roughened.–n = 11.

Darlington, Mosses of Michigan, fig. 118. Grout, Moss Flora of North America 3: Pl. 20 above.–**Fig. 783-785.**

In shallow pools or damp depressions in fens, bogs, or boggy woods. Circumpolar; Greenland, south to Oregon, Michigan, Ohio, and Connecticut; Australia.

CHEBOYGAN CO.–Bryants Bog, Gleasons Bog, Nichols Bog, Livingston Bog, Mud Lake, Little Lake 16. EMMET CO.–Galloway Bog, Wilderness State Park. MACKINAC CO.–Peggley Lake, Little Dollar Lake.

*Calliergon stramineum,* as the name indicates, is somewhat straw-colored. The plants are pretty and easily recognized by their slender, nearly simple stems ending in

narrow, terete, shiny points. As Braithwaite so quaintly put it, "The leaves often throw out radicles from the tips." Even when such radicles cannot be found, large, differentiated cells from which they are initiated may be demonstrated easily.

Much like *Calliergon stramineum,* and likewise often bearing radicles at the leaf tips, is **Calliergidium pseudostramineum** (C. M.) Grout. It can be distinguished by the fact that the leaves are not crowded and appressed in cuspidate points at the tips of stems and branches, and in shape they are distinctly tapered to a narrowly rounded apex. A rare species, it has been found once in Michigan, in Delta County. It may occur elsewhere in the Upper Peninsula, in wet places, especially in the crevices of wet rocks in stream gorges and near waterfalls. (It is probably an acidophile.) The occurrence of radicles at leaf tips is not worth too much emphasis. They also occur on occasion at leaf tips of *Drepanocladus fluitans* and *D. exannulatus.*

2. **Calliergon trifarium** (Web. & Mohr) Kindb.—Plants in loose mats 4-16 cm. high, frequently mixed with other mosses, green or more often yellow- or golden-brown, dark-brown below. Stems elongate, erect-ascending, simple or sparsely forked, soft and flexible when moist, brittle and usually smoothly terete when dry, more turgid when moist. Leaves crowded, erect or imbricate when dry, sometimes loosely erect-spreading when moist, cucullate-concave, smooth or ± striolate when dry, 1-1.6 mm. long, elliptic to oblong-ovate, not decurrent, rounded at the apex; margins erect or frequently revolute at the extreme base, usually crenulate at the extreme apex; costa slender, single (or occasionally double or forked), about 1/3-2/3 the leaf length, rarely more; upper cells oblong-linear (short at the extreme apex); alar cells not particularly differentiated, somewhat enlarged and oblong with firm, often yellowish walls at the basal angles or almost across the insertion. Dioicous. Setae 30-50 mm. long; capsules 2.5-3.5 mm. long; annulus broad; operculum blunt; endostome segments perforate; cilia nodose, in 2's and 3's. Spores 13-15 $\mu$, very finely papillose.

Grout, Moss Flora of North America 3: Pl. 21 lower left.—**Fig. 786-788.**

Emergent from shallow water of pools or among sedges in rich fens (around beach pools in the Great Lakes area); probably restricted to calcareous habitats. Circumpolar; Greenland; British Columbia to Labrador, south to Oregon, Michigan, Ohio, and Connecticut.

EMMET CO.—Cecil Bay. MACKINAC CO.—Bois Blanc Island. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Clinton Lake.

A rare species of richly calcareous fens, usually growing as separate strands in tufts of *Drepanocladus* or *Scorpidium* (and easily overlooked). In the field, the terete, scarcely branched plants have a dark, varnished appearance, and the leaves have a spiral arrangement which is nearly lost on drying.

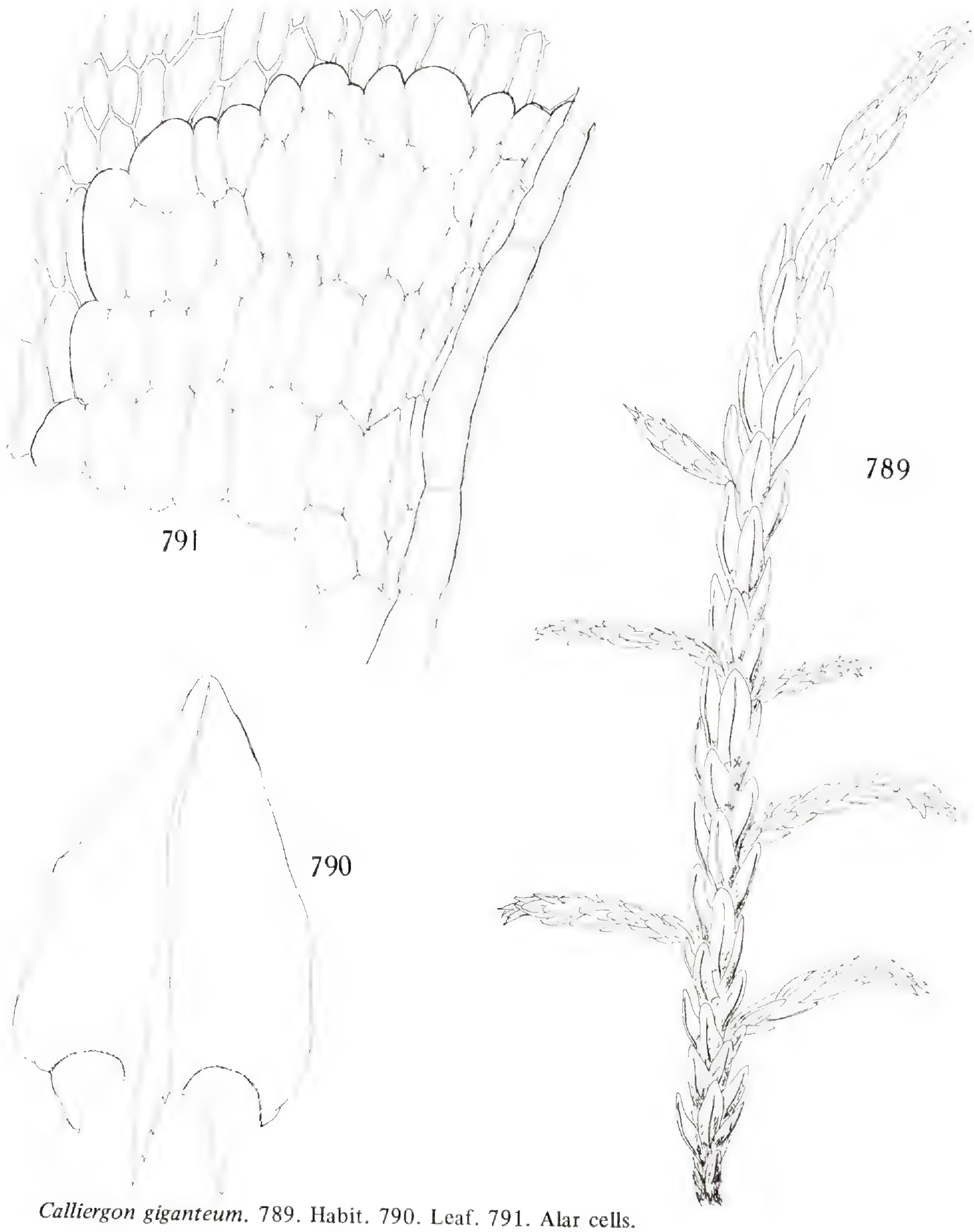
3. **Calliergon giganteum** (Schimp.) Kindb.—Rather robust plants in deep, loose, green, yellow-green, or brownish masses 7-20, rarely 35 cm. long. Stems ascending, pinnately branched; stems and branches cuspidate at the tips. Stem leaves not crowded, erect or erect-spreading except at the cuspidate tips, about 1.3-3 mm. long, broadly cordate-ovate, rounded and cucullate at the apex, broadly decurrent, entire, often indistinctly striate when dry; costa ending near the apex; upper cells linear-rhomboidal; alar cells large and hyaline, abruptly differentiated, in large, concave, decurrent auricles. Branch leaves narrower, usually wide-spreading and rolled when dry. Dioicous. Setae 45-70 mm. long, orange-brown; capsules 2.5-3 mm. long; annulus none; oper-

culum apiculate; endostome segments very narrowly perforate; cilia well developed, nodulose, in 2's-4's. Spores 13-17 $\mu$, finely papillose.

Grout, Moss Flora of North America 3: Pl. 19A.–**Fig. 789-791.**

Emergent (or sometimes submerged) in shallow, usually temporary pools or ditches or at the edge of springs or brooks, in bogs, fens, and wooded swamps. Circumpolar; Greenland to Alaska, south to Washington, Colorado, Michigan, and Pennsylvania.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Burt Lake, Douglas Lake, Livingston Bog, Grass Bay, south of Mackinaw City. EMMET CO.–Arnott Lake, Sturgeon Bay Point, Cecil Bay, Big Stone Bay, Conway Bog. MACKINAC CO.–Bois Blanc Island, Epoufette. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Presque Isle Corporation, south of Onaway State Park, Kelsey Pond, Clinton Lake.




*Calliergon giganteum*. 789. Habit. 790. Leaf. 791. Alar cells.

A common species of considerable variability and yet easily recognized by the irregularly pinnate arrangement of branches, dioicous inflorescences, and abruptly differentiated alar cells. (The branches are generally remote and unequal so that the effect is by no means frondose.) Many recent authors have erroneously included *C. giganteum* in the synonymy of *C. cordifolium,* which has sparse and irregular branching, autoicous inflorescences, and gradually differentiated alar cells (not bordered above by short cells).

4. **Calliergon richardsonii** (Mitt.) Kindb. *ex* Warnst.—Rather robust plants in soft, loose, green or yellowish masses up to 15 cm. high. Stems ascending, irregularly or occasionally subpinnately branched; stems and branches ± cuspidate at the tips. Stem leaves erect- or wide-spreading, concave and often somewhat rolled toward the apex when dry, about 1.7-2 mm. long, oblong- or cordate-ovate, rounded-obtuse, sometimes radiculose at back near the apex, somewhat decurrent, entire; costa about ½-¾ the leaf length, usually forked at the apex; alar cells abruptly enlarged, inflated, and hyaline in large, concave groups. Autoicous. Setae 45-60 mm. long, orange-red; capsules 2.5-3 mm. long; annulus none; operculum apiculate; endostome segments narrowly perforate, the cilia well developed, nodulose, in groups of 2-3. Spores 15-22 $\mu$, very finely papillose. —n = ca. 20.

Grout, Moss Flora of North America 3: Pl. 17A (figs. 10-12).—**Fig. 792.**

On soil in wet depressions or shallow pools in muskeg and, in our area, spruce-white cedar bogs. Circumpolar; apparently rare but widely scattered from Greenland to Alaska and south to Manitoba, Michigan, and Vermont.

CHEBOYGAN CO.—Hebron Swamp.

Intermediate in many ways between *C. giganteum* and *C. cordifolium,* this species, rare and local in occurrence, is distinguished by an autoicous inflorescence, irregular branching, relatively short costa, and abruptly differentiated alar cells.

5. **Calliergon cordifolium** (Hedw.) Kindb.—Rather robust plants in soft, loose, green or yellow-green masses about 7-15 cm. high. Stems ascending, sparsely and irregularly branched; stems and branches cuspidate at the tips. Stem leaves not crowded, erect-spreading (somewhat imbricate near the stem and branch tips), 1.8-3 mm. long, cordate-ovate, rounded and somewhat cucullate at the apex, sometimes radiculose at back near the apex, broadly decurrent, entire; costa ending near the apex; cells at the apex shortly oval or rhombic; upper median cells linear-rhomboidal; alar cells large, inflated, and hyaline in large, decurrent groups but not abruptly differentiated. Autoicous (or rarely polygamous, the perigonial buds rarely including a few archegonia). Setae 35-65 mm. long, orange-brown; capsules 2-3 mm. long; annulus none; operculum apiculate; segments of endostome narrowly perforate; cilia well developed, nodulose, in 2's and 3's. Spores 13-18 $\mu$, very finely papillose.—n = 10, 21, 20-22.

Conard, How to Know the Mosses, (ed. 2) fig. 205. Grout, Mosses with Hand-lens and Microscope, Pl. 76. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 40, (ed. 2) Pl. 44. Welch, Mosses of Indiana, fig. 180.—**Fig. 793-795.**

On various substrata in or at the margins of temporary pools and along streams, frequently in ditches or wet depressions, often emergent or temporarily submerged, in swamps, swales, or peat bogs. Circumpolar; Greenland to Alaska and south to Washington, Montana, Illinois, and Pennsylvania.

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*Calliergon richardsonii.* 792. Leaves.
*Calliergon cordifolium.* 793. Habit. 794. Leaf. 795. Alar cells.

CHEBOYGAN CO.–Reeses Bog, Carp Creek, Douglas Lake, Burt Lake, Livingston Bog, Mud Lake. EMMET CO.–Maple River, Pleasantview Swamp, Arnott Lake, Galloway Bog, Wilderness State Park. MACKINAC CO.–Bois Blanc Island, Epoufette, Rexton Lake, Koski Pond, McNamara Pond. PRESQUE ISLE CO.–South of Onaway State Park.

This common species has often been confused with *C. giganteum,* from which it differs patently in its loose and irregular, sparse habit of branching, autoicous inflorescences, and gradually differentiated alar cells.

## 9. **Calliergonella** Loeske

Rather robust plants in loose, shiny, green, yellow-green, or yellow-brown tufts or masses. Stems greenish or yellowish, erect or ascending, irregularly or subpinnately branched; cortical cells large and hyaline; stems and branches cuspidate at the tips; paraphyllia few, at branch bases. Stem leaves erect or erect-spreading (crowded and imbricate at tips of stems), concave, broadly oblong-ovate to elliptic, rounded and usually bluntly and inconspicuously apiculate at the apex, entire; costa none or short and double; upper cells smooth, linear-flexuose; cells at insertion thicker-walled and porose, those at the basal angles subquadrate, inflated, hyaline, and thin-walled in conspicuous auricles. Branch leaves shorter, narrower, oblong or oblong-lanceolate, blunt or obtuse. Dioicous; perichaetial leaves erect, long, lance-acuminate. Capsules curved-cylindric; annulus large, of about 4 rows of cells; operculum ± apiculate; endostome with entire or narrowly perforate segments and appendiculate cilia in 3's and 4's.–The name is a diminutive of *Calliergon,* and the plants have an aspect suggestive of that genus.

**Calliergonella cuspidata** (Hedw.) Loeske–Plants up to about 10 cm. high. Stem leaves 1.8-2.2 mm. long. Setae 35-50 mm. long; capsules 3-4 mm. long. Spores 17-22 $\mu$, finely roughened.–n = 9, 10, 11.

Darlington, Mosses of Michigan, fig. 119. Grout, Mosses with Hand-lens and Microscope, fig. 167 (as *Calliergon*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 40 (as *Acrocladium*), (ed. 2) Pl. 44.–**Fig. 796-798.**

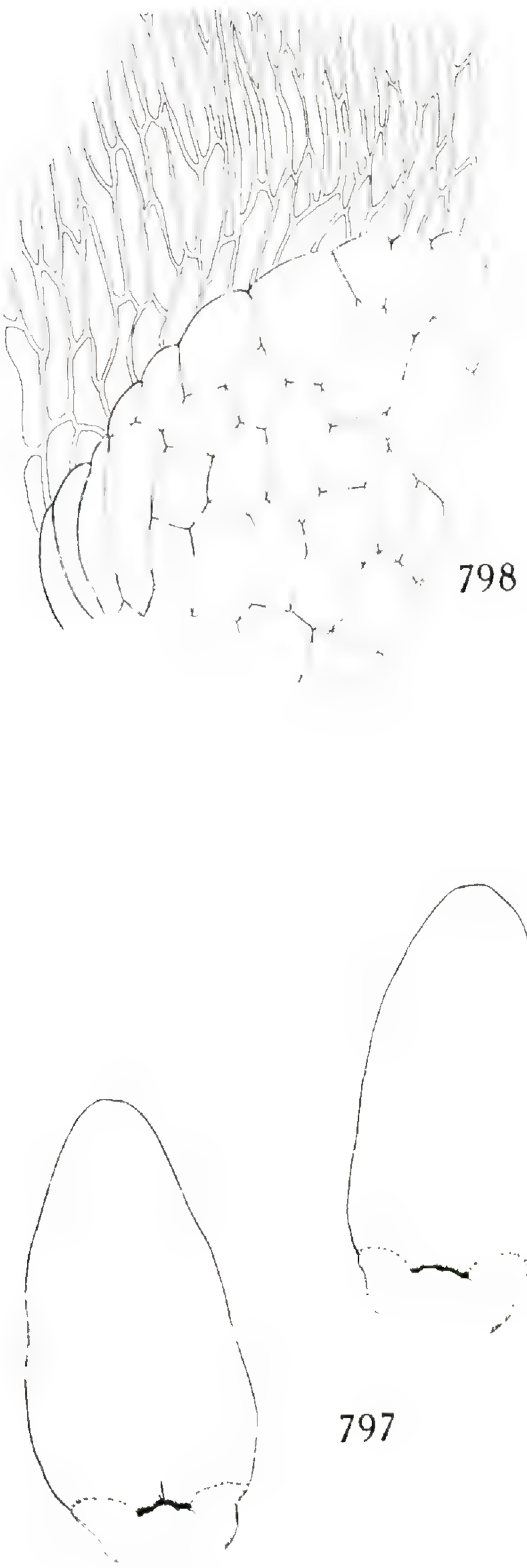
In rich fens and sedge meadows; a calciphile. Europe, North Africa, Macaronesia, Asia, Jamaica, Argentina, and New Zealand; British Columbia to California, Nova Scotia to Wisconsin, south to Iowa and Tennessee.

CHEBOYGAN CO.–Reeses Bog, Mud Lake, Little Lake 16. EMMET CO.–Alanson, Cecil Bay, Wilderness State Park, Waugoshance Point, Conway, Bear Creek Township, Lawrence Lake. MACKINAC CO.–St. Martins Bay, Peggley Lake. PRESQUE ISLE CO.–Evergreen Beach, Clinton Lake, Kelsey Lake.

The leaves are crowded and convolute at the cuspidate tips of stems and branches. The species somewhat resembles *Pleurozium schreberi* but grows in much wetter habitats and has much more cuspidate stem and branch tips, more strikingly differentiated basal leaf auricles, and large cortical cells. When growing submerged, it is more robust and more plumose, with spreading leaves.

## 10. **Scorpidium** (Schimp.) Limpr.

Plants robust, turgid or julaceous, in loose mats in very wet places, often submerged in shallow, stagnant water, yellow-green or red-gold, sometimes brownish or blackish, often slimy or lime-encrusted. Stems creeping or ascending, scarcely to irregularly or subpinnately branched. Leaves large, crowded, very concave and often cucullate, erect or ± falcate-secund, smooth or striolate and sometimes ± rugose when dry, broadly oblong or oblong-ovate, acute or obtuse, often minutely apiculate; margins erect or incurved above, entire; costa weak, short and double, or lacking; cells smooth, linear, those at the insertion shorter, wider, incrassate and porose, a few cells at the basal angles ± differentiated (small and subquadrate, or somewhat inflated). Dioicous; perichaetial leaves erect, lanceolate, striate. Capsules curved-cylindric; annulus present; endostome cilia in 2's and 3's.–Named for a fancied resemblance to a scorpion with its tail curved upward, in reference to the curved-secund leaves of *S. scorpioides.*



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*Calliergonella cuspidata.* 796. Habit. 797. Leaves. 798. Alar cells.

Leaves ± falcate-secund, at least at the tips of stems and branches; alar cells hyaline, thin-walled, and inflated in small and inconspicuous groups 1. *S. scorpioides*

Leaves loosely imbricate to spreading, not at all secund or slightly so at branch tips; alar cells shortly oblong and subquadrate, not hyaline, thin-walled, or inflated 2. *S. turgescens*

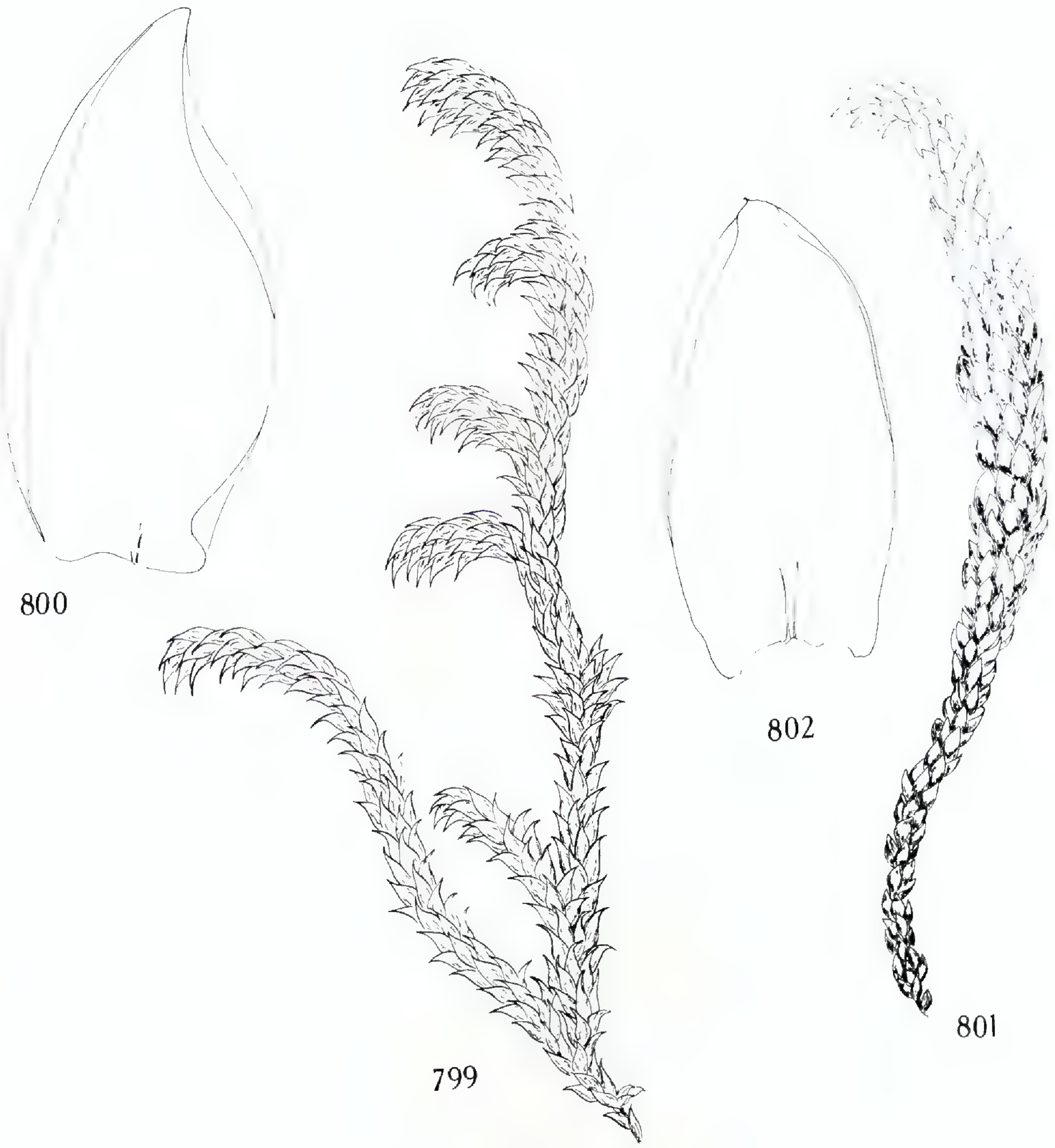
1. **Scorpidium scorpioides** (Hedw.) Limpr.—Plants robust and turgid, up to 25 cm. long, crowded and erect or looser and prostrate, sparsely to shortly and unequally pinnate, shiny, green, yellow, brown, or reddish to blackish-red, often encrusted with a slimy deposit. Leaves ± secund, at least at the tips of stems and branches, often falcate-secund, ± striolate and often irregularly and obscurely rugose-wrinkled when dry, concave, 2-3, rarely 4.5 mm. long, elliptic to oblong-ovate, obtuse or acute, often apiculate; costa weak, short and double, or none; upper cells long,

linear-flexuose; cells at insertion oblong-linear, thick-walled, and porose, a few cells at the extreme angles hyaline, thin-walled, ± inflated. Setae 30-45 mm. long; capsules 2-3 mm. long. Spores 13-15 $\mu$, very finely roughened.–n = 8, 10+1; 2n = 16.

Conard, How to Know the Mosses, (ed. 2) fig. 267. Darlington, Mosses of Michigan, fig. 117. Grout, Moss Flora of North America 3: Pl. 27C.–**Fig. 799-800.**

A calciphile, in shallow water and often submerged among sedges at the margins of pools in rich fens or swales. Circumpolar; Andes of South America; Greenland to Alaska, south to Montana, Wisconsin, Ohio, and New Jersey.

CHEBOYGAN CO.–Douglas Lake, Blanchards Bog, Mud Lake, Grass Bay, Black Lake. EMMET CO.–Arnott Lake, Ramona Beach, Sturgeon Bay Point, Cecil Bay, Wilderness State Park. MACKINAC CO.–Bois Blanc Island, Mackinac Island, Mud Lake. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Clinton Lake.




*Scorpidium scorpioides.* 799. Habit. 800. Leaves.
*Scorpidium turgescens.* 801. Habit. 802. Leaf.

*Scorpidium scorpioides* can be quite beautiful with its robust, fatly julaceous stems and branches and deep, red-gold color and attractive sheen. In Great Britain, it is said to grow sometimes in acid habitats (with *Drepanocladus revolvens*), but in North America it is limited to shallow water of highly calcareous fens where it is usually submerged, covered with a limey deposit, and, as often as not, slippery, slimy, and partially decomposed. The very broad, secund, and somewhat rugose leaves with short points are distinctive. The species is suggestive of a *Drepanocladus,* differing most clearly, of course, in the absence of a costa and also by short leaf points. As compared with *S. turgescens,* its secund leaves and absence of differentiated alar cells are helpful characteristics.

2. **Scorpidium turgescens** (T. Jens.) Loeske—Rather stout or robust plants in dense, soft, yellow-brown, ± shiny masses about 5-20 cm. high. Stems erect, sparsely branched, usually rather turgid. Leaves crowded and loosely imbricate or sometimes rather remote and erect-spreading to spreading, not at all secund or slightly so at branch tips, concave or sometimes cucullate, not or slightly striolate when dry, 2-3.2 mm. long, broadly oblong-ovate, obtuse or rounded-obtuse and (at least in younger leaves) narrowed to a small, recurved apiculus, somewhat rounded to the insertion; costa slender, double, about 1/3 the leaf length; upper cells linear; cells at insertion yellow, oblong-linear, incrassate, and porose, those toward the angles shortly oblong and subquadrate, firm- or thick-walled (not hyaline, thin-walled, and inflated). [Sporophytes very rare; not seen.]

Grout, Moss Flora of North America 3: Pl. 26B (as *Calliergon*).—**Fig. 801-802.**

A calciphile, growing in rich fens, often emergent or temporarily submerged. (It is said to occur in Great Britain also in acid habitats.) Circumpolar; Ecuador; Greenland to Alaska, south to British Columbia, Colorado, Michigan, Ontario, and Newfoundland.

MACKINAC CO.—Bois Blanc Island.

The plants are stoutly julaceous with broad, concave leaves erect or ± spreading, rounded-obtuse and often abruptly apiculate. It has the look of a *Calliergon*, but the costa is double, and the alar cells are scarcely inflated.

## BRACHYTHECIACEAE

Plants slender to robust, in loose or dense mats or tufts, often ± shiny. Stems creeping to erect-ascending, freely and irregularly to pinnately branched; paraphyllia mostly lacking. Leaves in many rows, appressed or erect-spreading, occasionally ± secund, mostly plicate, broadly ovate to lanceolate, ± long-acuminate (or rarely blunt or rounded at the apex); costa single and well developed, mostly ending below the apex, frequently projecting at the tip as a dorsal spine; cells prosenchymatous, mostly elongate, rhomboidal to linear-flexuose, smooth or rarely papillose at back because of projecting upper angles, laxer and often porose at base, mostly subquadrate at the basal angles, sometimes forming well-marked alar groups. Perichaetia lateral; perichaetial leaves differentiated. Setae ± elongate, frequently roughened; capsules inclined to horizontal or rarely erect and symmetric, mostly rather short, ovoid or oblong-cylindric and asymmetric, ± curved when dry and empty, the neck short and inconspicuous, generally stomatose; annulus usually poorly differentiated; operculum conic, blunt, acute, or rostrate; peristome double, the 16 teeth lance-subulate, generally red-brown, mostly cross-striolate below, trabeculate at back; endostome generally free

and about as long as the teeth, the basal membrane usually high, the segments keeled, usually lance-subulate, the cilia well developed or rarely rudimentary or lacking. Spores spherical. Calyptra cucullate, usually naked.—As compared with the Amblystegiaceae, which generally have slender, curved capsules with yellow-brown exostomes, the Brachytheciaceae characteristically have short capsules with dark, red-brown peristome teeth.

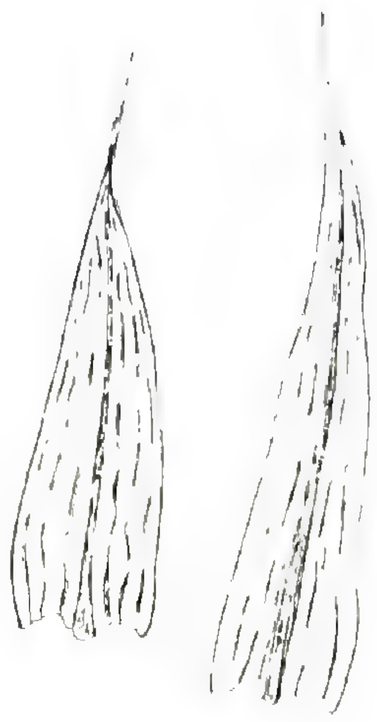
The generic concepts have recently been revised by Robinson (Bryol. 65: 73-146. 1962), but I take a more traditional view, more or less that presented in *Die natürlichen Pflanzenfamilien.*

1. Leaves broadly oblong-ovate and rounded at the apex, often appearing apiculate because of abruptly incurved upper margins; costa short and double — 8. *Pleurozium*
1. Leaves ovate to lanceolate, blunt to acuminate; costa single
 2. Stems erect, pinnately branched, conspicuously tomentose nearly to the apex; leaves lanceolate, gradually acuminate, strongly plicate — 1. *Tomenthypnum*
 2. Stems prostrate or ± ascending, irregularly to subpinnately branched, occasionally ± dendroid, not tomentose; leaves ovate to lanceolate, bluntly acute or variously acuminate, mostly striate or moderately plicate when dry
  3. Leaves acute or obtuse; apical cells or branch leaves short and rhomboid-hexagonal, differentiated from median cells — 5. *Eurhynchium*
  3. Leaves acuminate; apical cells of branch leaves elongate, not much different from median cells
   4. Leaf cells papillose at back because of projecting cell ends — 3. *Bryhnia*
   4. Leaf cells smooth
    5. Leaves very concave, oblong-ovate, abruptly filiform-acuminate — 4. *Cirriphyllum*
    5. Leaves not conspicuously concave, variously acuminate but not abruptly filiform
     6. Operculum obliquely long-rostrate; leaves smooth, ovate or ovate-lanceolate, usually somewhat complanate — 6. *Rhynchostegium*
     6. Operculum blunt or acute to apiculate; leaves mostly ± plicate, mostly lanceolate, not or rarely obscurely complanate
      7. Plants small and slender; leaves smooth, serrulate all around, especially at the basal angles; costa subpercurrent, indistinct at the midleaf, often bearing rhizoids or subcylindric brood bodies at back above — 7. *Rhynchostegiella*
      7. Plants small or mostly medium-sized; leaves ± plicate, entire or serrulate but not conspicuously toothed at the basal angles; costa ending above the leaf middle or rarely subpercurrent, distinct at the middle, not bearing rhizoids or brood bodies at back above — 2. *Brachythecium*

## 1. **Tomenthypnum** Loeske

Rather robust plants in loose or dense, yellow-green to golden-brown tufts, rigid and often glossy when dry. Stems erect, pinnately branched, conspicuously brown-tomentose nearly throughout; branches horizontal and straight. Stem and branch leaves similar, stiffly erect-spreading or occasionally ± secund, strongly plicate, long-lanceolate and very slenderly acuminate; margins plane and entire; costa slender, ending about 3/4-4/5 up the leaf; upper cells long-linear, rather thick-walled, smooth; cells at insertion shorter, broader, and porose, the alar cells scarcely differentiated. Dioicous; perichaetial leaves erect, long, lance-subulate, plicate or striate. Setae long, slender, reddish, smooth; capsules orange-brown, strongly inclined to horizontal, oblong-cylindric from a short neck, curved and asymmetric, constricted below the mouth when dry; annulus of 3 layers of cells; operculum conic, acute; stomata in the neck; peristome teeth lanceolate, dark, red-brown, cross-striolate below, papillose above, bordered, trabeculate; endostome yellow-brown, finely papillose, as long as the teeth, with a high basal membrane, keeled, perforate segments; and well-developed, nodulose cilia in 3's and 4's. Calyptrae naked.—The name refers to the tomentum of felted hairs characteristic of a moss otherwise suggestive of *Hypnum* (in a broad sense).

**Tomenthypnum nitens** (Hedw.) Loeske—Plants 5-15 cm. high. Stem leaves 3-4 mm. long, radiculose at the back of the costa at base; costa very slender and



*Tomenthypnum nitens.* 803. Habit. 804. Leaves. 805. Upper cells of leaf.
*Brachythecium velutinum.* 806. Habit. 807. Branch leaves. 808. Upper cells of branch leaf.

difficult to see because of plications. Setae 27-47 mm. long; capsules 2-3 mm. long. Spores 13-17 $\mu$, very finely papillose.—n = 10, 12.

Darlington, Mosses of Michigan, fig. 127 (as *Camptothecium*). Grout, Mosses with Hand-lens and Microscope, fig. 157 (as *Camptothecium*).—**Fig. 803-805.**

Very common in the North and characteristic of black spruce muskegs and fens, frequent in the Great Lakes area in swampy, calcareous habitats such as *Thuja* swamps and open, marly bogs. Circumpolar; Greenland to Alaska, south to Colorado, Wisconsin, and Pennsylvania.

CHEBOYGAN CO.—Reeses Bog, Gorge of Carp Creek, Iron Bridge, Mud Lake, Grass Bay. EMMET CO.—Cecil Bay, Conway Bog, Lawrence Lake. MACKINAC CO.—Mackinac Island, Hendricks. PRESQUE ISLE CO.—Evergreen Beach, Hammond Bay, Mast Point, Kelsey Pond, Clinton Lake.

A characteristic moss of rich fens where it is associated with *Sphagnum warnstorfii, Campylium stellatum,* and other pronounced calciphiles, recognized by robust, stiffly erect, pinnately branched stems felted with tomentum and by erect, plicate leaves which are often shiny when dry. The var. **falcifolium** (Ren. *ex* Nich.) Podp., with falcate-secund leaves, has been found nearby in Ontario. It occupies more acid habitats than the var. *nitens,* at the tops of *Sphagnum* hummocks with *S. fuscum*, for example.

## 2. **Brachythecium** BSG

Plants slender to moderately robust, in green, yellowish, golden, or whitish-green mats, often somewhat shiny. Stems creeping or curved and decumbent, sometimes erect-ascending, irregularly to subpinnately branched, often stoloniform at the ends. Stem and branch leaves usually somewhat differentiated: Stem leaves crowded, erect-spreading or spreading, occasionally subsecund, ± concave, mostly ± plicate; ovate to lanceolate, usually long-acuminate, rarely short-pointed, short- to rather long-decurrent; margins mostly plane, finely toothed all around or only toward the apex, or sometimes entire; costa single, usually extending well up the leaf but rarely subpercurrent; cells smooth, mostly elongate, rhomboidal to oblong-linear, shorter and laxer at the base and usually subquadrate or oblong-hexagonal at the basal margins, rarely well-differentiated in ± conspicuous alar groups. Branch leaves mostly shorter and narrower, with costa weaker and usually shorter. Perichaetial leaves erect or squarrose from a sheathing base, slenderly long-acuminate. Setae ± elongate, smooth or roughened (sometimes only in the upper half); capsules inclined to horizontal or rarely erect, typically rather short and broad, oblong-ovoid and asymmetric, sometimes longer and cylindric, curved (especially when dry and empty), smooth; annulus usually differentiated; operculum conic or convex-conic, blunt or acute; stomata in the short neck; peristome teeth brown to red-brown, cross-striolate below, papillose at the tips, trabeculate; endostome free, the basal membrane high, segments lance-acuminate, narrowly perforate or gaping along the keel, cilia well developed and nodulose to appendiculate (or rarely rudimentary or lacking). Calyptrae naked.—The name means short capsule; in most species of *Brachythecium* the capsule is relatively short and thick as compared with many other *Hypnum*-like mosses, and *Amblystegium* especially.

1. Costa disappearing in the acumen to percurrent
   2. Plants small; branch leaves 0.6-0.9 mm. long; costa ending in the acumen; upper cells 3-5:1, oblong-hexagonal to shortly oblong-rhomboidal; setae 7-12 mm. long, rough throughout — 2. *B. reflexum*
   2. Plants larger; branch leaves 1-1.6 mm. long; costa percurrent or nearly so; upper cells longer, about 5-8:1, oblong-rhomboidal; setae 8-22 mm. long, lightly papillose above — 3. *B. populeum*
1. Costa ending well below the apex
   3. Branch leaves entire or essentially so — 8. *B. turgidum*
   3. Branch leaves serrulate
      4. Stems ± dendroid; leaves (especially of stems) broadly and noticeably decurrent — 11. *B. rivulare*
      4. Stems spreading and irregularly to subpinnately branched; leaves not or only slightly decurrent
         5. Plants small and slender
            6. Plants soft and silky; branches not terete; leaves falcate-secund; quadrate alar cells few; autoicous; setae rough throughout; capsules asymmetric and horizontal to pendulous — 1. *B. velutinum*
            6. Plants coarser; branches terete or subjulaceous when dry, not falcate-secund; quadrate alar cells numerous; dioicous; setae smooth; capsules nearly erect and symmetric — 5. *B. acuminatum*
         5. Plants medium-sized to rather robust
            7. Setae smooth; leaves plicate
               8. Dioicous; alar cells small, quadrate, rather opaque — 6. *B. oxycladon*
               8. Autoicous; alar cells subquadrate or short-oblong, not particularly small, rather lax and ± pellucid — 7. *B. salebrosum*
            7. Setae rough, at least above; leaves smooth or sometimes indistinctly plicate
               9. Setae papillose only above (and rarely smooth throughout); branch leaves concave, often homomallous, 1.3-2 mm. long — 4. *B. plumosum*
               9. Setae papillose throughout; branch leaves not particularly concave, not homomallous, 2-2.5 mm. long
                  10. Branch leaves spreading, loosely complanate when dry, twisted at the apex; costa

serrulate and usually projecting as a minute spine at back; margins ± serrate nearly all around; cilia of endostome appendiculate 9. *B. curtum*

10. Branch leaves erect, only occasionally twisted at the apex; costa smooth, rarely projecting as a minute dorsal spine; margins less strongly toothed, serrulate only above or sometimes nearly to the base; cilia nodulose 10. *B. rutabulum*

1. **Brachythecium velutinum** (Hedw.) BSG—Small plants in dark- or yellow-green, rather soft and silky mats, irregularly to subpinnately branched. Stem and branch leaves similar. Branch leaves usually rather widely spaced, loosely erect- to wide-spreading and ± falcate-secund (especially at branch tips) when dry, erect-spreading when moist, about 1-1.5 mm. long, narrowly to broadly lanceolate, gradually acuminate, usually twisted at the apex, shortly decurrent, not or only faintly plicate; margins plane, serrulate; costa extending well above the middle, serrulate at back above; median cells linear, 8-12:1; quadrate alar cells few. Autoicous. Setae 7-15 mm. long, brown or red-brown, rough throughout; capsules about 1.5-2 mm. long, oblong-cylindric, horizontal or somewhat pendulous, curved and asymmetric, ± contracted below the mouth when dry; annulus of 2 rows of cells; operculum bluntly conic; cilia of endostome nodose, in groups of 2 or 3. Spores 10-13 $\mu$, smooth or very minutely roughened.—n = 10, 11, 12.

Conard, How to Know the Mosses, (ed. 2) fig. 249. Grout, Mosses with Hand-lens and Microscope, Pl. 66. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 51, (ed. 2) Pl. 56.—**Fig. 806-808.**

On soil, sometimes on rock or bark at base of trees, in dry or rather moist woods, often on sandy forest trails. Circumpolar; British Columbia to Labrador, south to Oregon, Montana, Michigan, and New York.

CHEBOYGAN CO.—Mullett Lake, Little Lake 16, Weber Lake. EMMET CO.—Pellston Hills, Wycamp Lake, Big Stone Bay. MACKINAC CO.—Caffey Corner. PRESQUE ISLE CO.—Loon Lake.

This is our smallest *Brachythecium*. It is scarcely velvety, as the name suggests, but as compared with *B. reflexum*, it is soft and silky, with loosely falcate-secund leaves. It is characteristically found on light soil of forest trails, especially in dry, aspen stands or in moister hardwood forests, such as beech-maple communities.

2. **Brachythecium reflexum** (Starke *ex* Web. & Mohr) BSG—Small, dark- or yellow-green plants in loose or dense mats. Stems pinnately branched; branches terete. Stem leaves about 1-1.2 mm. long, deltoid-ovate, abruptly narrowed to a flexuose-spreading acumen, rounded to the insertion, excavate at the basal angles and broadly decurrent. Branch leaves loosely erect to imbricate (and sometimes slightly homomallous) when dry, erect-spreading when moist, about 0.6-0.9 mm. long, lanceolate, gradually acuminate, sometimes ± twisted at the apex, decurrent; margins serrate above, serrulate nearly to the base, sometimes slightly reflexed; costa ending in the acumen, serrulate at back at or near the tip; upper cells short, 3-5:1 or rarely somewhat longer, oblong-hexagonal or shortly oblong-rhomboidal; alar cells short-rectangular or subquadrate. Autoicous. Seta 7-13 mm. long, rough throughout, orange-brown to dark-red; capsules 1.5-1.8 mm. long, strongly inclined to horizontal, shortly ovoid, asymmetric, not constricted below the wide mouth, brownish, becoming blackish with age; annulus of 2 rows of cells, fragmenting; operculum conic or convex-conic, mammillate to stoutly apiculate; cilia of endostome appendiculate, in 2's and 3's. Spores 11-16 $\mu$, finely papillose.—n = 10, 11, 15, 20.

Darlington, Mosses of Michigan, fig. 126. Grout, Mosses with Hand-lens and Microscope, fig. 148.—**Fig. 809-812.**

On rocks, soil, logs, stumps, exposed roots, and bases of trees in rather dry to moist woods. Circumpolar; Alaska to Labrador, south to Oregon, Michigan, and Virginia.

CHEBOYGAN CO.–Douglas Lake, Carp Creek, Colonial Point, Mud Lake, Grass Bay, Little Lake 16. EMMET CO.–Maple River Township, Pellston Dunes, Pellston Hills, Wycamp Lake, Cross Village, Five Mile Creek. MACKINAC CO.–Mackinac Island, Gros Cap, Ozark, Little Dollar Lake. PRESQUE ISLE CO.–Mast Point, Loon Lake.

Most common on bark at base of trees (often with *Hypnum pallescens*, *Homomallium adnatum*, and *Platydictya subtile*), the plants are small and dark-green, with stem leaves abruptly acuminate, rounded to the insertion, and broadly decurrent; the costa of branch leaves is serrulate at back at or near the tip.

3. **Brachythecium populeum** (Hedw.) BSG–Plants relatively slender, in dense, green or yellow-green mats. Branches slender and terete. Branch leaves erect and not or only slightly plicate when dry, erect-spreading when moist, 1-1.6 mm. long, lanceolate, slenderly acuminate; margins serrulate in the upper ½, revolute below; costa disappearing at or near the apex; upper cells firm-walled, oblong-rhomboidal; alar cells subquadrate in numerous rows. Stem leaves ovate-lanceolate, about 1.4-2 mm. long. Autoicous. Setae 8-22 mm. long, lightly roughened above, reddish; capsules 1-2 mm. long, strongly inclined to horizontal, asymmetric, oblong-ovoid; annulus of 1-2 rows of cells; operculum conic, acute or apiculate; cilia of endostome in groups of 2 and 3. Spores 12-14 $\mu$, very finely papillose.–n = 9, 10, 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 246e. Grout, Mosses with Hand-lens and Microscope, fig. 150.–**Fig. 813-814.**

On rock or soil over rocks. Europe; Azores; Asia; British Columbia; Nova Scotia to Manitoba and south to Virginia.

CHEBOYGAN CO.–Colonial Point. EMMET CO.–Five Mile Creek. MACKINAC CO.–Little Dollar Lake.

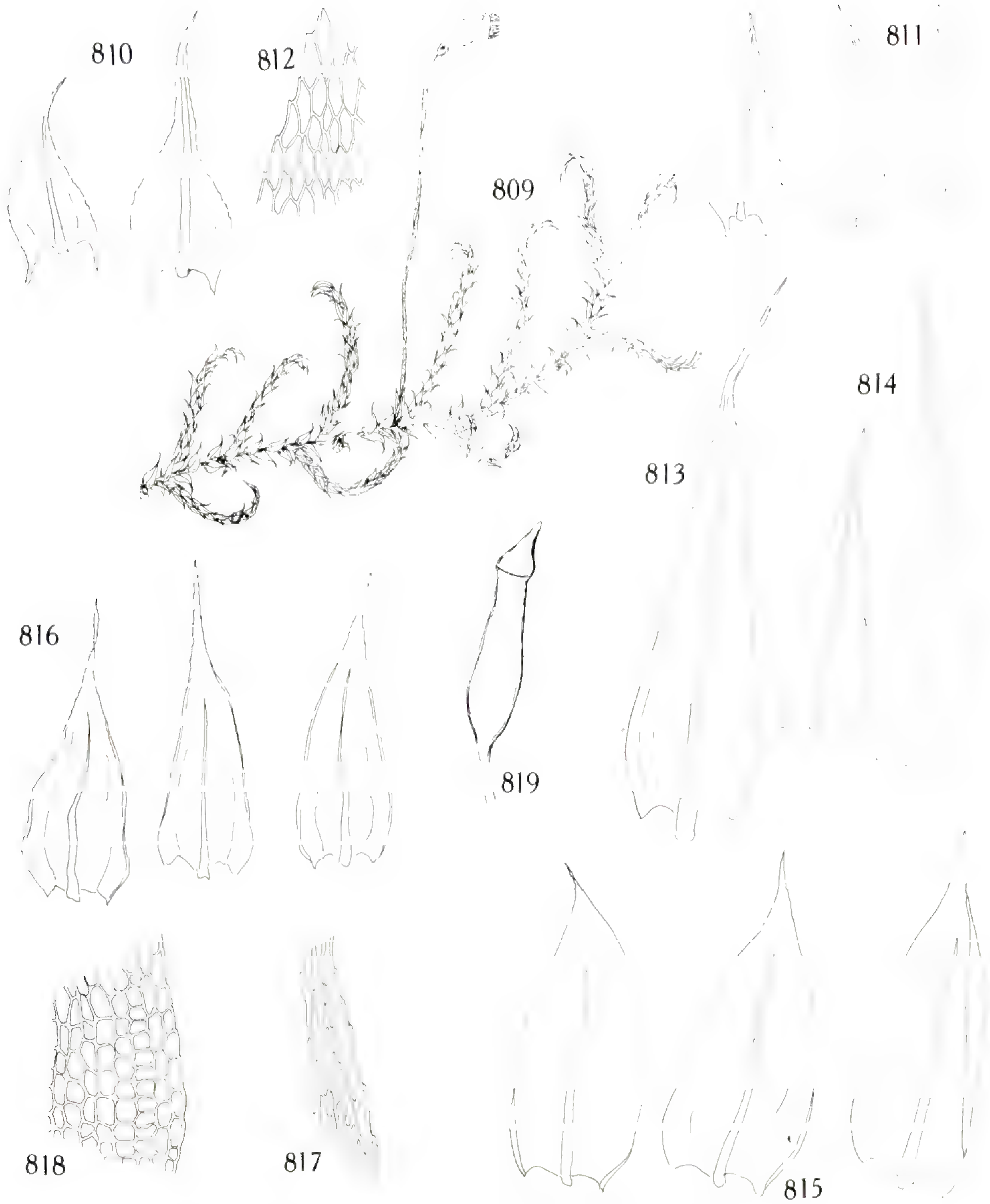
Relatively slender plants, usually on rocks, with terete branches and erect-spreading leaves tapered to a long, narrow acumen in which the costa disappears.

4. **Brachythecium plumosum** (Hedw.) BSG–Plants of medium size, green or, more often, yellow to brownish, shiny. Leaves often homomallous, concave, smooth or occasionally faintly striolate, 1.3-2 mm. long, lanceolate or ovate-lanceolate, acuminate, serrulate above; costa about 2/3 the leaf length; upper cells linear; alar cells subquadrate in small groups. Autoicous. Setae 7-16 mm. long, dark-red, papillose above (or occasionally smooth throughout); capsules 1.3-2 mm. long, oblong-ovoid, asymmetric, inclined to horizontal, dark-brown; annulus of 2 rows of cells; operculum conic and acute to apiculate or short-rostrate; cilia of endostome appendiculate, in groups of 1-3. Spores 13-18 $\mu$, nearly smooth.–n = 10, 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 246 (as *B. flagellare*). Grout, Mosses with Hand-lens and Microscope, fig. 149. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 52 & (ed. 2) Pl. 57 (as *B. flagellare* and var. *homomallum*). Welch, Mosses of Indiana, fig. 153 (as *B. flagellare*).–**Fig. 815.**

On moist rocks (usually in or near streams), rarely on soil. Nearly cosmopolitan; British Columbia to Oregon and Arizona, Labrador to Manitoba and south to Georgia and Arkansas.

CHEBOYGAN CO.–Gorge of Carp Creek, Mill Creek. MACKINAC CO.–Ozark.




*Brachythecium reflexum*. 809. Habit. 810. Stem leaves. 811. Branch leaves. 812. Upper cells of branch leaf.

*Brachythecium populem*. 813. Stem leaf. 814. Branch leaves.

*Brachythecium plumosum*. 815. Branch leaves.

*Brachythecium acuminatum*. 816. Branch leaves. 817. Upper cells of branch leaf. 818. Alar cells of branch leaf. 819. Capsule.

The plants are characteristic of moist rocks along streams. Useful characteristics include the yellowish or brownish color, and concave, smooth, and often homomallous leaves.

5. **Brachythecium acuminatum** (Hedw.) Aust.—Slender, green or yellowish, shiny plants in extensive mats. Stems creeping, closely branched; branches usually erect, short, terete and usually subjulaceous when dry. Stem and branch leaves similar,

usually crowded, erect when dry, erect-spreading or spreading when moist, somewhat biplicate or sometimes nearly smooth, 1-1.5 mm. long, ovate or ovate-lanceolate, gradually or abruptly acuminate, slenderly acute, often twisted at the apex; margins reflexed below, serrulate in the upper half; costa about 2/3 to 3/4 the leaf length, often ending in a minute tooth at back; upper cells linear-rhomboidal (shorter at the apex of the leaf); alar cells subquadrate in several to numerous rows. Dioicous. Setae 7-20 mm. long, dark-red, smooth; capsules erect and symmetric or slightly curved, cylindric, 1.5-2.2, rarely 3 mm. long; annulus none; operculum conic, often obliquely apiculate; stomata in the short neck; cilia of endostome none or rudimentary. Spores 15-17 $\mu$, very finely papillose or nearly smooth.

Darlington, Mosses of Michigan, fig. 125 (as *Chamberlainia cyrtophylla*). Grout, Mosses with Hand-lens and Microscope, Pl. 65, also fig. 15 (as *B. cyrtophyllum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 48, 49 (as *B. acuminatum* & *B. cyrtophyllum*), (ed. 2) Pl. 53, 54 (as *Chamberlainia acuminata* & *B. cyrtophylla*). Welch, Mosses of Indiana, fig. 144 (as *Chamberlainia*), 145 (as *C. cyrtophylla*).–**Fig. 816-819.**

On bark at base of trees and less frequently on rocks or soil. Saskatchewan to New Brunswick and south to Texas and Florida.

CHEBOYGAN CO.–Reeses Bog, Polypody Bluff (near Douglas Lake). EMMET CO.–Pellston Hills.

The plants are a small version of *B. oxycladon,* with branches terete when dry and with rather numerous, small, quadrate alar cells. The capsules are nearly erect and symmetric but not too different from the longish, somewhat inclined capsules of *B. oxycladon* and scarcely justify a generic separation as *Chamberlainia,* in Grout's original concept. The genus *Brachythecium* in the inclusive and classical sense of the *Bryologia Europaea* seems to me natural, recognizable, and "Linnaean," and I see no reason to re-apportion some of the species as *Chamberlainia* and *Bryhnia* in the emended sense proposed by Robinson (Bryol. 65: 73-146. 1962).

**Brachythecium acuminatum** var. **cyrtophyllum** (Kindb.) Redf. *ex* Crum n. comb. [*B. cyrtophyllum* Kindb., Ottawa Nat. 4: 63. 1890. *B. acuminatum* ssp. *cyrtophyllum* (Kindb.) Kindb. *ex* Macoun & Kindb., Cat. Canad. Pl. 1: 191. 1892. *B. acuminatum* var. *cyrtophyllum* (Kindb.) Redf., Ann. Mo. Bot. Gard. 59: 79. 1972, *comb. illeg.*] Often hidden in synonymy, this variety is recognizable by leaves shorter, broader, and more concave, with shorter tips (acute to short-acuminate) and shorter cells. Redfearn erroneously attributed the combination to Welch and provided no reference to a basionym which would have validated the transfer in this name. The variety is widespread, probably ranging with the species proper.

6. **Brachythecium oxycladon** (Brid.) Jaeg. & Sauerb.–Plants in extensive, somewhat shiny, yellow-green or yellow-brown mats. Stems creeping, freely branched; branches usually closely foliate and ± terete. Stem leaves up to 2.2 mm. long. Branch leaves erect or erect-spreading, concave, plicate, 1.5-2 mm. long, lanceolate, gradually acuminate, serrulate nearly all around; costa 2/3-3/4 the leaf length; upper cells linear-rhomboidal; alar cells subquadrate, relatively small and somewhat grayish-opaque. Dioicous. Setae 8-27 mm. long, usually reddish, smooth; capsules suberect or inclined, curved, oblong-cylindric, about 2-3 mm. long; annulus none; operculum conic, acute or ± acuminate; cilia paired. Spores 11-16 $\mu$, finely papillose.

Conard, How to Know the Mosses, (ed. 2) fig. 241a-c, e. Grout, Mosses with Hand-lens and Microscope, Pl. 63. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 69. Welch, Mosses of Indiana, fig. 150.–**Fig. 820-822.**

On shaded soil, rocks, rotten wood, and bases of trees, often in rather dry or disturbed habitats. Europe; eastern North America from southeastern Canada to Minnesota and Nebraska, south to North Carolina and Missouri.

CHEBOYGAN CO.–Wolffs Bog, Mud Lake. EMMET CO.–Maple River, Larks Lake, Cross Village, Middle Village, Five Mile Creek. MACKINAC CO.–Mackinac Island, Sand Lake, Ozark, Caffey Corner, McKays Creek.

Very common and most likely to be confused with *B. salebrosum,* which is autoicous and has larger, laxer, more transparent alar cells. (The *Bryologia Europaea* pictures which Grout reproduced in his *Mosses with Hand-lens and Microscope* describe the areolation more eloquently than I could hope to do in words.)

**Brachythecium digastrum** C. M. & Kindb. *ex* Macoun & Kindb. is a smallish version of *B. oxycladon.* It has broadly decurrent stem leaves, especially in forms with leaves widely spaced. Its branch leaves are narrowed to broad, acute or shortly acuminate, blunt, serrate points. The cells near the leaf tip are short, and the costa is somewhat toothed at back. Unlike *B. oxycladon,* it appears to be autoicous. It is variable and poorly understood, though seemingly widespread in eastern North America.

7. **Brachythecium salebrosum** (Web. & Mohr) BSG–Rather robust plants in loose, somewhat shiny, green, yellowish or brownish mats. Stems creeping or ± ascending, freely branched. Stem leaves 2-2.5 mm. long; branch leaves loosely erect or erect-spreading, sometimes loosely falcate, usually strongly plicate, 1.8-2 mm. long, lanceolate or ovate-lanceolate, gradually long-acuminate; margins irregularly recurved below, serrulate above; costa about 2/3 the leaf length; upper cells linear, those at the insertion shorter and broader with thicker, pitted walls, the alar cells subquadrate and rather thin-walled, not opaque. Autoicous. Setae 10-27 mm. long, yellowish or reddish, smooth; capsules rather shortly oblong-cylindric, curved and asymmetric, inclined to nearly horizontal, 2-2.5 mm. long; annulus poorly developed in 1 row; operculum conic, acute or apiculate; cilia of endostome (1)2. Spores 13-18 $\mu$, finely papillose.–n = 10+1, 13, 15, 20.

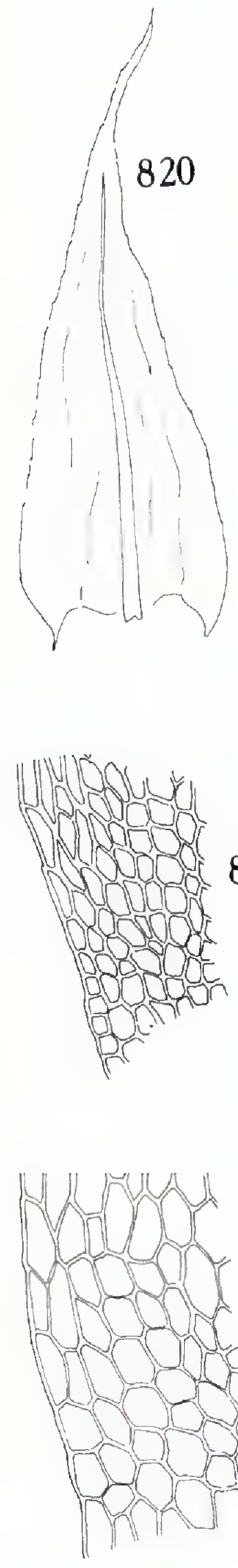
Conard, How to Know the Mosses, (ed. 2) fig. 243. Grout, Mosses with Hand-lens and Microscope, Pl. 62. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 49, (ed. 2) Pl. 54. Welch, Mosses of Indiana, fig. 146.–**Fig. 823-827.**

On shaded soil, stones, bases of trees, and logs, often in rather dry and disturbed places (common in lawns). Circumpolar; Tasmania and Kerguelen; Alberta and eastward across the continent, widespread in eastern North America.

CHEBOYGAN CO.–Douglas Lake, Reeses Bog, Grapevine Point, Colonial Point, Maple River, Ellis Township, Mill Creek. EMMET CO.–Carp Lake, Good Hart, Cecil Bay, Big Stone Bay. MACKINAC CO.–Mackinac Island, McKays Creek. PRESQUE ISLE CO.–Hammond Bay.

Very common in disturbed places and most likely to be confused with *B. oxycladon.* The important differences are well illustrated by the *Bryologia Europaea* illustrations reproduced in Grout's *Mosses with Hand-lens and Microscope* (pp. 272 and 275). *B. oxycladon* is dioicous and has small, rather opaque, quadrate alar cells. *B. salebrosum* is autoicous and has a more open areolation of larger, laxer, subquadrate cells at the basal angles.

**Brachythecium oxycladon** fo. **falcatum** Grout, known from several local areas, including the type locality at Douglas Lake, seems to me a small form of this species (somewhat resembling *B. velutinum* because of distinctly falcate-secund leaves).



*Brachythecium oxycladon.* 820. Branch leaf. 821. Alar cells of branch leaf. 822. Capsule.
*Brachythecium salebrosum.* 823. Habit. 824. Branch leaf. 825. Upper cells of branch leaf. 826. Alar cells of branch leaf. 827. Capsule.
*Brachythecium turgidum.* 828. Branch leaf.

**Brachythecium campestre** (C. M.) BSG is much like *B. salebrosum* (although it may be more closely related to *B. curtum*). The branch leaves are erect-spreading and usually somewhat falcate-secund, not at all complanate, serrate above and serrulate nearly to the base; the alar cells are subquadrate and shortly oblong; the costa is toothed at back above; the inflorescences are autoicous and the setae lightly and inconspicuously papillose. It has not been found in this part of Michigan.

8. **Brachythecium turgidum** (C. J. Hartm.) Kindb.—Stout plants in loose, shiny, golden-green or golden-brown tufts. Stems erect-ascending, irregularly and sparsely

branched; branches stout and ± turgid or subjulaceous, pointed. Stem and branch leaves similar, loosely erect or erect-spreading, moderately plicate, 2.5-3 mm. long, ovate-lanceolate, rather abruptly narrowed to a long, slender acumen, somewhat decurrent; margins narrowly reflexed below, entire or occasionally slightly serrulate above; costa ending above the leaf middle; upper cells linear; alar cells laxly subquadrate or short-oblong. Autoicous. Setae 18-25 mm. long, reddish, smooth; capsules about 2 mm. long, oblong-cylindric, asymmetric, nearly horizontal; annulus of 1 row of cells; operculum conic, apiculate; cilia of endostome 2(3). Spores 11-20 $\mu$, finely papillose.—n = 10, 14.

**Fig. 828.**

On wet soil and rocks near streams, pools, or waterfalls; probably limited to calcareous habitats. Circumpolar; scattered and rare in the Western Hemisphere, from Greenland and Labrador to Alaska and south to Quebec and Michigan.

MACKINAC CO.–Bois Blanc Island. PRESQUE ISLE CO.–Mast Point.

Similar to *B. salebrosum* but larger, somewhat turgid, and growing in wet, calcareous places.

9. **Brachythecium curtum** (Lindb.) Limpr.–Plants of moderate size, in loose, yellow or light-green, shiny mats. Stems ascending or arched, irregularly branched. Stem leaves ovate-lanceolate, acuminate, somewhat decurrent, with fairly numerous, lax, oblong cells at the basal angles. Branch leaves not crowded, spreading and loosely complanate wet or dry, not plicate, concave, 2-2.5 mm. long, oblong-lanceolate, gradually acuminate, twisted at the apex, slightly decurrent; margins plane, sharply serrulate or, more often, serrate nearly all around; costa slender, about 5/6 the leaf length, minutely toothed at back above and usually ending in a small dorsal tooth; cells linear-flexuose, a few at the basal angles lax and oblong to subquadrate. Autoicous; perichaetial leaves sheathing at base, with long, wide-spreading acumina. Setae 10-30 mm. long, brownish or orange, becoming red, papillose-roughened throughout; capsules 1.5-2 mm. long, horizontal or subpendulous, asymmetric, oblong, brown or blackish-brown with age; annulus of 2 rows of cells; operculum conic, acute; cilia of endostome appendiculate, in groups of 2 and 3. Spores 11-15 $\mu$, smooth or minutely roughened.—n = 20.

**Fig. 829.**

On various substrata, often in bogs. Europe and eastern North America from Nova Scotia to Minnesota and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Gorge of Carp Creek, Gates Bog, Mud Lake. EMMET CO.–Pellston Hills, Stutsmanville. MACKINAC CO.–Hendricks, Hessel.

If my concept is correct, all American reports of *B. starkei* (Brid.) BSG can be referred here. Though related to that species, *B. curtum* has a distinctive appearance because of loosely spreading, more or less complanate, and more gradually tapered leaves. The leaves are twisted at their tips.

10. **Brachythecium rutabulum** (Hedw.) BSG–Plants moderately robust, glossy, green or yellow. Stems arched, freely and irregularly to subpinnately branched; branches ascending. Stem leaves 2-3 mm. long, ovate, acuminate, broadly decurrent, with numerous, large, oblong cells at the basal angles. Branch leaves loosely erect,

smooth or only slightly plicate when dry, 2-2.5 (rarely 3) mm. long, oblong- to ovate-lanceolate, slenderly acuminate, with the apex occasionally twisted, not or only slightly decurrent; margins distinctly serrulate in the upper half or less, sometimes nearly to the base; costa very slender, about 2/3-3/4 the leaf length, smooth at back and only rarely projecting as a minute, inconspicuous dorsal spine; cells long-linear, flexuose, a few at the basal angles enlarged and oblong. Autoicous; perichaetial leaves elongate, sheathing at base, with long, slender, somewhat serrulate, wide-spreading acumina. Setae 13-30 mm. long, red-brown or red, papillose-roughened throughout; capsules 2.5-3 mm. long, horizontal, somewhat curved, asymmetric, oblong, dark- or red-brown; annulus of 2 rows of cells; operculum conic, acute; cilia of endostome nodulose, in groups of 2-4. Spores 13-20 $\mu$, very finely roughened or nearly smooth.—n = 5, 6, 10, 10+1, 11, 12, 13, 20, 22; 2n = 20.

Conard, How to Know the Mosses, (ed. 2) fig. 247. Grout, Mosses with Hand-lens and Microscope, Pl. 64, Moss Flora of North America 3: Pl. 8 (fig. 3), as var. *flavescens*. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 50, (ed. 2) Pl. 55. Welch, Mosses of Indiana, fig. 151.—**Fig. 830.**

On soil, rocks, logs, and bark at base of trees in moist, shady places. Nearly cosmopolitan; eastern United States from New England to Michigan, south to Missouri, Kentucky, and New Jersey.

CHEBOYGAN CO.—Reeses Bog, Burt Lake, Gorge of Carp Creek, Smiths Bog, Wolffs Bog, Livingston Bog, Mill Creek, Mullett Lake. EMMET CO.—Five Mile Creek, Cecil Bay. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, Caffey Corner. PRESQUE ISLE CO.—Presque Isle Lighthouse.

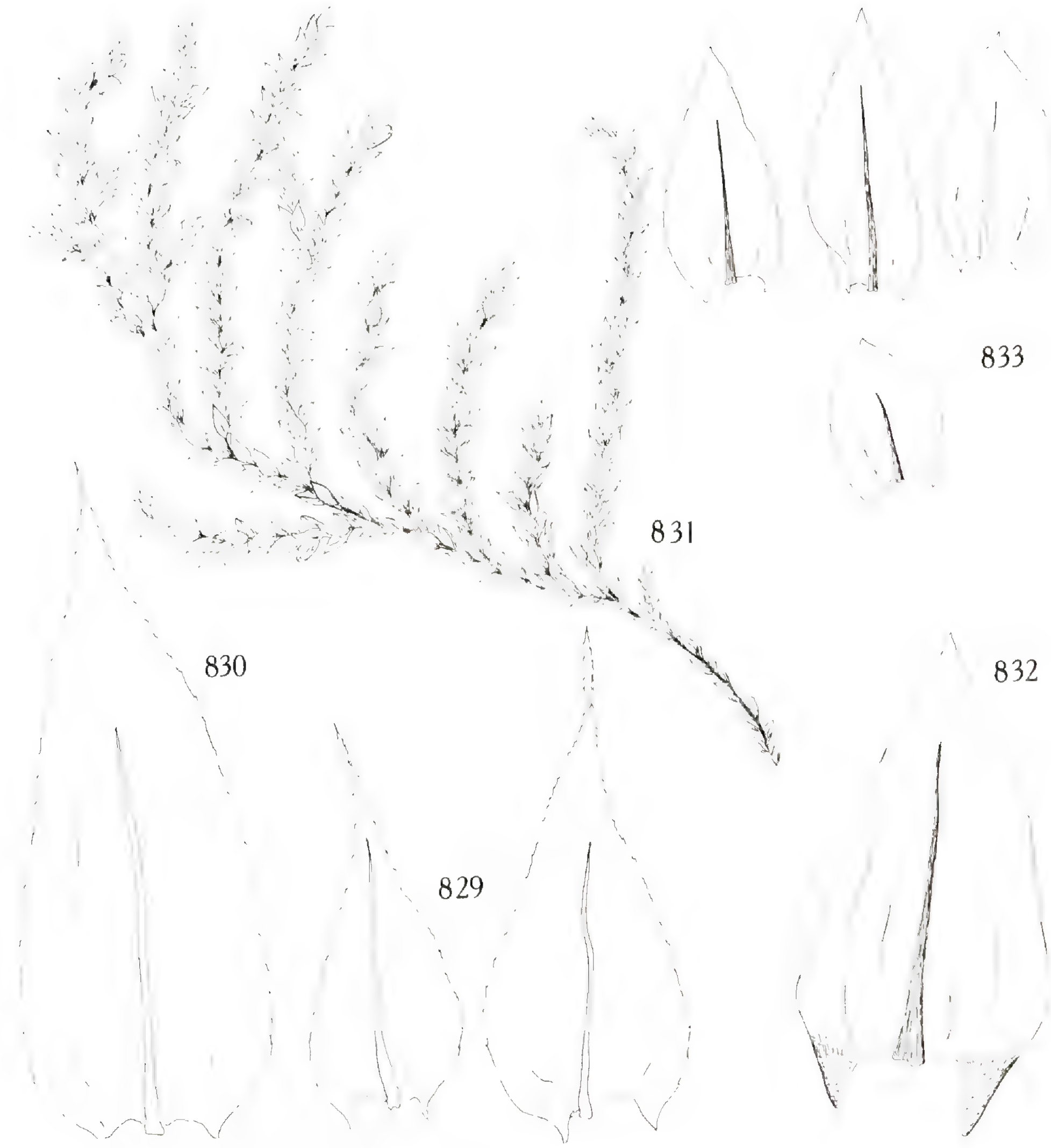
A troublesome species often resembling *B. salebrosum*, and like it autoicous, but having a roughened seta and leaves less plicate and usually more glossy-green. It grows in wetter habitats, too. It apes *B. rivulare* because of rather decurrent leaves but differs in its autoicous inflorescences and non-dendroid form of growth.

11. **Brachythecium rivulare** BSG—Plants fairly robust, in extensive, pale- or whitish- to yellow-green, ± shiny mats. Primary stems creeping; secondary stems typically erect-ascending and irregularly dendroid. Stem leaves 1.8-2.5 mm. long, broadly oblong-ovate or gradually or rather abruptly short-acuminate, with alar cells conspicuously enlarged and short-oblong in broadly decurrent groups. Branch leaves erect or erect-spreading, concave, often slightly plicate, 1-1.5, sometimes 2 mm. long, rounded-ovate to ovate-lanceolate, sharply or bluntly acute to short-acuminate, somewhat decurrent; margins serrulate above; costa about 2/3 the leaf length; upper cells linear; alar cells lax or ± enlarged. Autoicous (and apparently also dioicous). Setae 15-25 mm. long, red-brown, rough throughout; capsules asymmetric, inclined to horizontal, 2-2.5 mm. long; annulus of about 2 rows of cells; operculum conic, apiculate; cilia 2-3. Spores 15-22 $\mu$, finely papillose.—n = 6, 10+1, 11, 12, 13, 16.

Conard, How to Know the Mosses, (ed. 2) fig. 248. Grout, Mosses with Hand-lens and Microscope, fig. 147. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 51, (ed. 2) Pl. 56. Welch, Mosses of Indiana, fig. 152.—**Fig. 831-833.**

On shaded soil, rocks, and other substrata in seepy places around springs and near brooks. Circumpolar; Kerguelen; across Canada and the northern United States, south to Virginia and Missouri in the East.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Burt Lake, Mill Creek, Grass Bay. EMMET CO.—Sherett Lake, Wycamp Lake, Pellston Hills, Pleasantview Swamp, Conway Bog. MACKINAC CO.—Mackinac Island, Cut River, Epoufette. PRESQUE ISLE CO.—Hammond Bay, Evergreen Beach, Rainy River Falls.




*Brachythecium curtum.* 829. Branch leaves.
*Brachythecium rutabulum.* 830. Branch leaf.
*Brachythecium rivulare.* 831. Habit. 832. Stem leaf. 833. Branch leaves.

*Brachythecium rivulare* is recognized by its seepy habitat and pale, soft, somewhat dendroid habit of growth. The alar cells are greatly differentiated in broad decurrencies, especially on stem leaves. Being dioicous, it can be distinguished sexually from occasional puzzling forms of *B. rutabulum.*

The species was reported, by Aravilla Taylor, to be involved in the deposit of bog iron ore in Indiana (Bryol. 22: 38-39. 1919). I am dubious of this, as I can think of no obvious physiological method comparable to the carbon dioxide exchange resulting in tufa deposition. Flowers (Bryol. 36: 26-27. 1933) reported a calcareous tufa in Utah which had been deposited by a moss suggesting *Brachythecium rivulare.*

### 3. **Bryhnia** Kaur.

Plants slender to medium-sized, in loose or dense, green, yellowish, or brownish, somewhat shiny mats. Stems ascending from a creeping base, subpinnately branched or

somewhat dendroid. Stem leaves somewhat larger than branch leaves, broadly ovate to ovate-lanceolate, gradually or abruptly short- or fairly long-acuminate, decurrent. Branch leaves ovate-lanceolate to lanceolate, acute or acuminate, decurrent, ± striate when dry; margins serrulate nearly all around; costa ending below the apex; upper cells shortly oblong-rhomboidal to linear-rhomboidal, papillose at back because of projecting upper ends, longer and broader at base, not much differentiated at basal angles. Dioicous; perichaetial leaves clasping at a broader base and ending in a flexuose, wide-spreading subula. Setae elongate, red, rough throughout; capsules strongly inclined to horizontal, oblong-cylindric, somewhat curved, asymmetric, smooth; annulus narrow but well differentiated; operculum conic and apiculate to obliquely short-rostrate; stomata at base of the capsule; peristome teeth brown or red-brown and cross-striolate below, pale and papillose at the tips, bordered, trabeculate; endostome pale yellow-brown, papillose, with a high basal membrane, keeled, perforate segments, and nodulose cilia in groups of (1)2-3. Calyptrae naked or with a few scattered hairs.–Named for Nils Bryhn, a Norwegian bryologist.

Leaves ± spreading, ovate or ovate-lanceolate, acute or broadly acuminate, twisted at the apex (especially at branch tips), plane-margined; costa smooth at back, about 3/4-5/6 the leaf length; upper cells shortly oblong-rhomboidal, 3-4:1, minutely papillose at back
1. *B. novae-angliae*

Leaves loosely erect, lanceolate, acuminate, ± flexuose but not twisted at the apex; margins very narrowly recurved; costa toothed at back and ending in a spine; upper cells oblong-linear, strongly papillose at back
2. *B. graminicolor*

1. **Bryhnia novae-angliae** (Sull. & Lesq. *ex* Sull.) Grout–Medium-sized plants in soft, rather dense, bright- or yellow-green mats. Stems often somewhat dendroid. Stem leaves about 1-1.3 mm. long, broadly ovate or rounded-ovate, gradually or abruptly narrowed to a short or moderately long acumen. Branch leaves usually rather remote, spreading or erect-spreading and somewhat flexuose-contorted when dry, spreading when moist, 0.6-1.2 mm. long, ovate to ovate-lanceolate, acute or broadly acuminate, ± twisted at the apex (especially at branch tips); margins plane; costa 3/4-5/6 the leaf length, smooth at back; upper cells shortly oblong-rhomboidal, 3-4:1, minutely papillose at back because of projecting ends. Setae 10-20 mm. long; capsules 1.5-2 mm. long, dark red-brown; operculum apiculate to obliquely and stoutly short-rostrate; cilia of endostome 1-3. Spores 13-18 $\mu$, minutely papillose or nearly smooth. Calyptrae apparently naked.–n = 11.

Conard, How to Know the Mosses, (ed. 2) fig. 166d-e. Darlington, Mosses of Michigan, fig. 121. Grout, Mosses with Hand-lens and Microscope, fig. 152. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 69. Welch, Mosses of Indiana, fig. 136.–**Fig. 834-836.**

On soil, humus, logs, or rocks in wet, shady places, particularly in seepage near brooks. Europe and Asia; southeastern Alaska; Newfoundland to Ontario and the prairies, south to North Carolina and Tennessee.

CHEBOYGAN CO.–Reeses Bog, Douglas Lake, Burt Lake, Mill Creek. EMMET CO.–Pellston Hills. MACKINAC CO.–Cut River.

*Bryhnia novae-angliae* grows in seepy habitats where *Brachythecium rivulare* might also occur and is not unlike it in aspect. It can be distinguished, however, because of its leaves with twisted points and papillae formed by cell ends projecting at back. (*B. graminicolor* is much smaller and otherwise different, as indicated in the key.)

2. **Bryhnia graminicolor** (Brid.) Grout–Slender plants in dense, yellow-brown or sometimes green mats. Stem leaves 1-1.1 mm. long, ovate-lanceolate, acuminate. Branch

leaves loosely erect (or occasionally erect-spreading) and somewhat flexuose when dry, erect-spreading when moist, 0.4-0.6 mm. long, lanceolate, acuminate, not twisted at the apex; margins very narrowly and indistinctly recurved nearly all around; costa ending somewhat below the apex, toothed at back and ending in a small spine; upper cells oblong-linear, 6-8:1 (or in occasional broader-leaved forms only about 4:1), strongly papillose at back because of projecting ends. Setae 7-10 mm. long; capsules 1.5-2 mm. long, brown; operculum narrowed to a rather short, oblique beak; cilia of endostome 1-2. Spores 13-15 $\mu$, minutely papillose or nearly smooth. Calyptrae with a few scattered hairs.

Conard, How to Know the Mosses, (ed. 2), fig. 166a-c. Grout, Mosses with Hand-lens and Microscope, fig. 153a. Jennings, Mosses of Western Pennsylvania (ed. 1) Pl. 54, (ed. 2) Pl. 59. Welch, Mosses of Indiana, fig. 137.–**Fig. 837-838.**

On moist soil or rock (often calcareous), on banks of roads or streams, also on cliffs. New England and Ontario to Minnesota, south to North Carolina and Arkansas.

CHEBOYGAN CO.–Fairy Island (Douglas Lake), Mill Creek. MACKINAC CO.–Caffey Corner.

The plants are small, as compared with *B. novae-angliae,* with narrow, erect leaves not twisted at the tip and leaf cells narrow and strongly papillose at the upper ends.

## 4. **Cirriphyllum** Grout

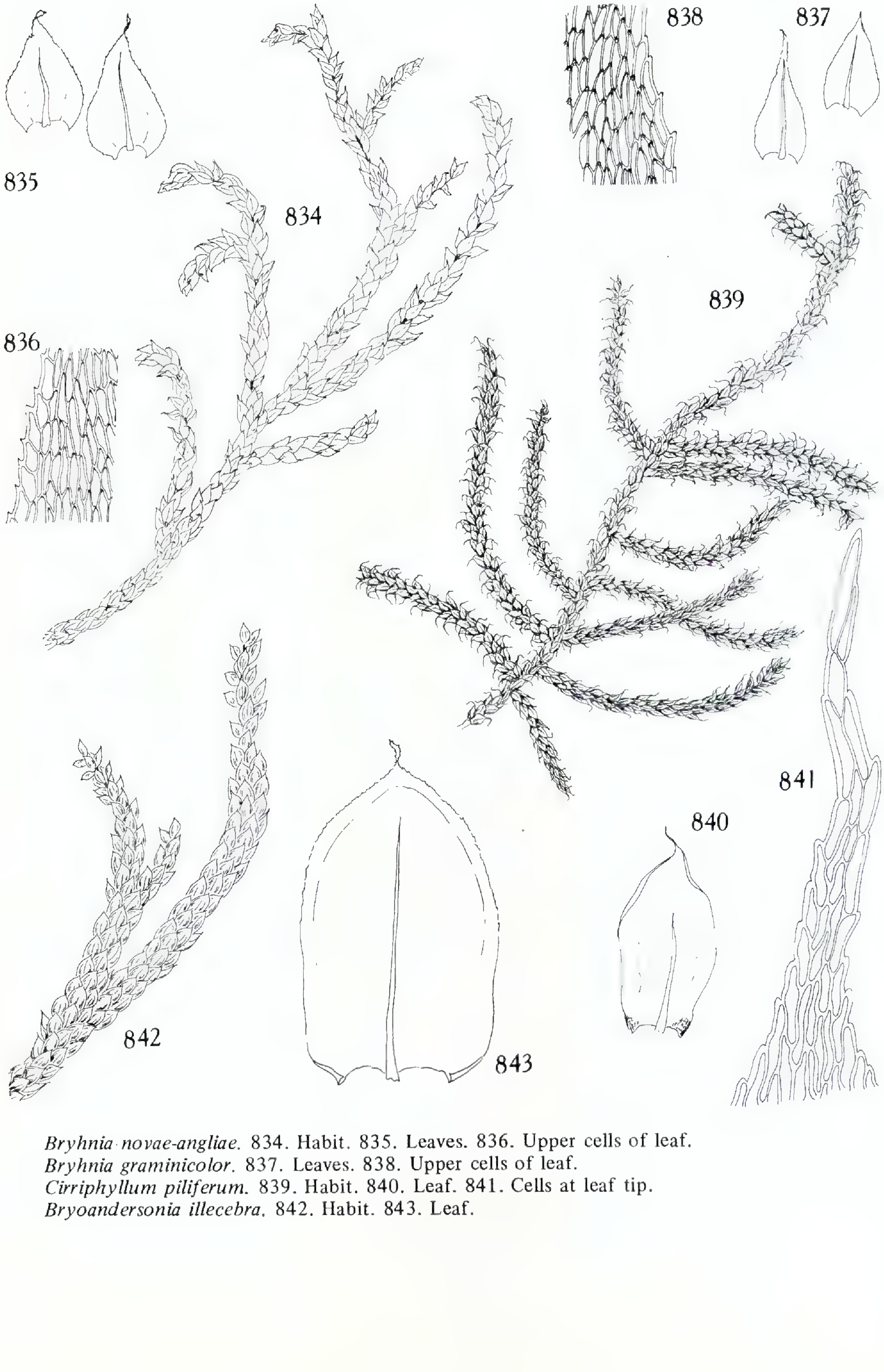
Plants slender to moderately robust, pale- or yellow-, rarely dark-green, mostly shiny. Stems creeping to ascending, irregularly to subpinnately branched; branches erect or ascending, terete and sometimes loosely julaceous. Leaves erect or erect-spreading, often imbricate when dry, very concave and often cucullate, not or weakly plicate, oblong or oblong-ovate or sometimes lanceolate, gradually or abruptly lance-acuminate to subulate, ± decurrent; margins erect, entire or serrulate; costa single, about 1/2-2/3 the leaf length; upper cells smooth, linear; alar cells short-oblong to subquadrate in somewhat differentiated groups. Dioicous; perichaetial leaves abruptly or gradually narrowed to a long, slender acumen from a sheathing base. Setae elongate, mostly rough; capsules inclined to horizontal, oblong-ovoid and asymmetric, rarely suberect and subcylindric; annulus differentiated; operculum conic, acute to long-rostrate; peristome teeth lanceolate, cross-striolate below, papillose above, bordered, trabeculate at back; endostome free, about as long as the teeth, basal membrane high, segments lance-acuminate, keeled and perforate, cilia well-developed, nodose. Calyptrae naked.–The name refers to hair-pointed leaves. Like *Rhynchostegium,* also with a long-beaked operculum, this genus is not as distinct from *Brachythecium* as one might like.

**Cirriphyllum piliferum** (Hedw.) Grout–Medium-sized plants in soft, loose, shiny, bright- or yellow-green mats. Leaves usually not particularly crowded, erect to erect-spreading, 1.3-2.5 mm. long, very concave, not or only slightly and irregularly plicate when dry, broadly oblong-ovate, ± rounded at the apex and abruptly filiform, broadly decurrent; margins erect, serrate at the apex, serrulate in the upper half or more; costa extending about 2/3 the leaf length; cells of the decurrencies enlarged and shortly oblong. Setae 10-30 mm. long, rough throughout; capsules ± curved and oblong-cylindric, about 2.5 mm. long; annulus of 2 rows of cells; operculum long-rostrate (up to 1.8 mm. long); stomata few, near the junction of urn and seta; peristome teeth dark, red-brown; endostome pale-brown, with cilia in 2's and 3's. Spores 11-15 $\mu$, finely papillose to nearly smooth.–n = 11, 12-14.

Darlington, Mosses of Michigan, fig. 124. Grout, Moss Flora of North America 3: Pl. 6 (figs. 1-23).–**Fig. 839-841.**

On humus in wet, shady places (locally in *Thuja* swamps). Circumpolar; Alaska, Victoria Island (Northwest Territories), Washington, Newfoundland to South Carolina and Michigan.

CHEBOYGAN CO.–Gorge of Carp Creek, Reeses Bog. EMMET CO.–Sherett Lake.




*Bryhnia novae-angliae.* 834. Habit. 835. Leaves. 836. Upper cells of leaf.
*Bryhnia graminicolor.* 837. Leaves. 838. Upper cells of leaf.
*Cirriphyllum piliferum.* 839. Habit. 840. Leaf. 841. Cells at leaf tip.
*Bryoandersonia illecebra.* 842. Habit. 843. Leaf.

The plants, suggestive of *Brachythecium,* are recognized by the soft, glossy appearance of the tumid branches. The leaves, very concave and softly plicate when dry, are abruptly narrowed to a slender, flexuose point (not really a hair-point as the generic name suggests). Not yet found in Michigan but no doubt occurring in the southern part is a typical denizen of the oak-hickory forest—**Bryoandersonia illecebra** (Hedw.) Robins. (fig. 842-843), also known as *Cirriphyllum boscii* (Schwaegr.) Grout. It is stoutly julaceous with broad, smoothly concave, cucullate leaves which end abruptly in a short, twisted point. The leaves are clasping at base and have small, thick-walled alar cells. The smooth setae and long-beaked opercula also aid in recognition.

## 5. **Eurhynchium** BSG

Plants rather small to fairly robust, dark, sordid-green and dull or light-green, yellowish, or brownish and often shiny when dry, in loose or dense mats or tufts. Stems creeping, arched and decumbent, or ascending, irregularly to pinnately (or rarely bipinnately) branched, sometimes ± dendroid, frequently stoloniform; paraphyllia none or few, at branch bases. Stem and branch leaves somewhat differentiated: Stem leaves erect and sometimes appressed or more commonly spreading to squarrose, sometimes loosely complanate, ± concave, often plicate, broadly ovate or subcordate, shortly and broadly acuminate or rather slenderly long-acuminate, somewhat to decidedly decurrent; costa ending at or above the leaf middle, often projecting at the tip as a dorsal spine; cells smooth, linear or oblong-linear, much shorter at the apex, shorter and broader at base, ± differentiated at the basal angles (small and subquadrate or rarely oblong and enlarged). Branch leaves narrower, broadly acute, obtuse, or rounded-obtuse (or rarely gradually acuminate), sometimes twisted at the apex, the apical cells generally shorter than the median, the terminal cell commonly short-rhombic. Perichaetial leaves ending in a mostly squarrose-recurved subula. Setae elongate, smooth or rough; capsules strongly inclined to horizontal, ovoid-cylindric to subcylindric, ± asymmetric; annulus differentiated; operculum slenderly and obliquely long-rostrate from a convex-conic base; stomata in the short neck; peristome teeth cross-striolate below, papillose above, bordered, trabeculate; endostome free, about as long as the teeth, the basal membrane high, segments lance-acuminate, keeled and perforate, the cilia mostly well developed, nodose or appendiculate. Calyptrae naked.—The name alludes to the well-developed beak of the operculum which, together with the short cells at the leaf tips, is the essential character of the genus.

1. Rather robust, autoicous plants of aquatic habitats, often submerged; branch leaves 1.2-1.5 mm. long or more; setae smooth ..... 3. *E. riparioides*
1. Rather small, dioicous or phyllodioicous plants of moist but not aquatic habitats; branch leaves smaller; setae smooth or rough
   2. Dioicous; branch leaves 0.8-1.2 mm. long, broadly ovate, acute; setae rough ..... 2. *E. hians*
   2. Phyllodioicous; branch leaves 0.5-1 mm. long, narrowly oblong-ovate, bluntly acute to rounded-obtuse; setae smooth ..... 1. *E. pulchellum*

1. **Eurhynchium pulchellum** (Hedw.) Jenn.—Relatively slender, usually shiny, green, yellowish, or brownish plants in extensive mats. Stems creeping, irregularly to pinnately branched; branches horizontal or erect-ascending, ± flattened or terete. Stem leaves erect, about 1 mm. long, ovate, acute. Branch leaves crowded and erect or, more typically, less crowded and erect to widely spreading, often slightly complanate, 0.5-1 mm. long, narrowly oblong-ovate, bluntly acute to rounded-obtuse, indistinctly striate, often twisted at the apex; margins serrulate all around; costa extending 5/6 or more the leaf length, ± toothed at back near the tip and projecting as a dorsal spine;

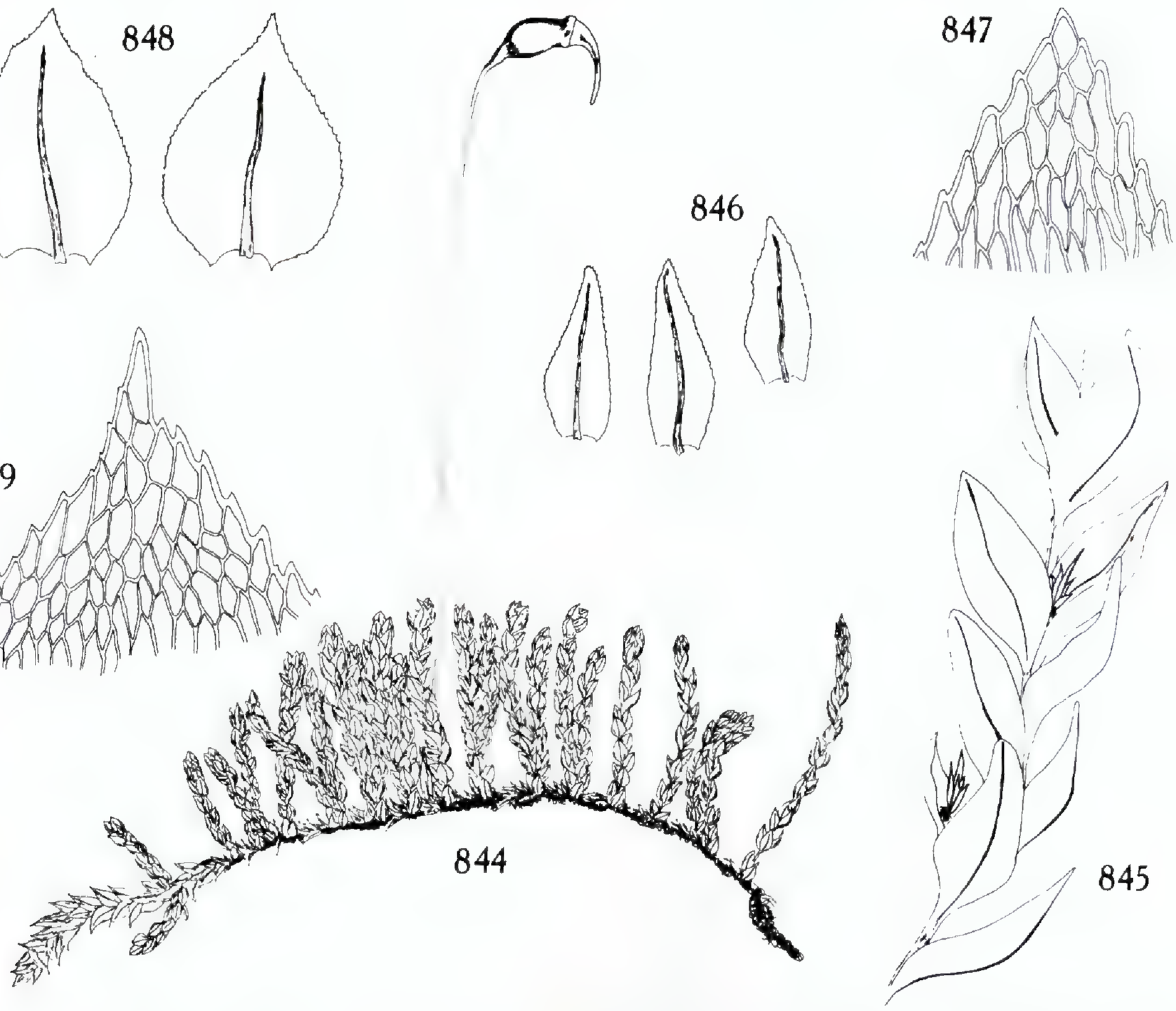
cells rhomboidal, short at the apex. Phyllodioicous. Setae 10-20 mm. long, becoming reddish, smooth; capsules 1.5-2 mm. long, oblong-cylindric, becoming somewhat constricted below the mouth and at the short neck; peristome teeth brown; endostome pale-brownish; cilia in groups of 2-3, well developed, nodulose. Spores 11-13 $\mu$, smooth or nearly so.—n = 10, 12 (as *E. praecox*).

Darlington, Mosses of Michigan, fig. 122. Grout, Mosses with Hand-lens and Microscope, Pl. 67 (as *E. strigosum*), Moss Flora of North America 3: Pl. 4 (figs. 1-17 & a-c), as *E. diversifolium* & *E. strigosum*. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 53 & (ed. 2) Pl. 58 (as var. *robustum*). Welch, Mosses of Indiana, fig. 139 (as var. *robustum*), 140 (as var. *praecox*).—**Fig. 844-847.**

On soil or humus, particularly on low mounds in woods, or on rotten logs or stumps, bark at base of trees, or rocks. Circumpolar; Mexico and Guatemala; northern South America; Alaska to Newfoundland, south to Arizona in the West, Georgia and Texas in the East.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Fairy Island (Douglas Lake), Colonial Point, Wolffs Bog, Livingston Bog, Ellis Township, Mud Lake, Mill Creek, Grass Bay, Little Lake 16. EMMET CO.—Levering, Arnott Lake, Pleasantview Swamp, Good Hart, Middle Village, Wycamp Lake, Cecil Bay, Big Stone Bay, Conway Bog. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Prentiss Bay, Gros Cap, Epoufette, Ozark, McNamara Pond. PRESQUE ISLE CO.—Ocqueoc River, Rainy River Falls, Bells Landing, Mast Point, Lamprey Experiment Station, Evergreen Beach.

This is one of our most common mosses. It characteristically grows on old stumps rotted nearly to the level of the forest floor or on low mounds of humic soil




*Eurhynchium pulchellum*. 844. Habit. 845. Dwarf male plants growing on large female plant. 846. Leaves. 847. Cells at leaf tip.
*Eurhynchium hians*. 848. Leaves. 849. Cells at leaf tip.

(perhaps associated with windthrow of trees and kept in a disturbed condition by extended exposure during the snow season). The plants are often pinnately branched and frequently brownish. The small, ovate, bluntly pointed leaves, typically spreading when moist are distinctive in comparison with other pleurocarps of woodland habitats.

The dwarf male plants are mere buds perched on the leaves of the female plants. Lewis Anderson, investigating local collections, was able to show that a distinctive chromosome recognizable at meiosis is transmitted to the male plants and is indeed a sex chromosome. (For further information on sexual dimorphism, see the discussion of *Dicranum polysetum*, above.)

2. **Eurhynchium hians** (Hedw.) Sande-Lac.–Dull or shiny, green or yellowish plants with irregular to subpinnate branching. Stem leaves 1-1.2 mm. long, ovate or triangular-ovate, slenderly short-acuminate. Branch leaves erect to erect-spreading, 0.8-1.2 mm. long, ovate (or sometimes ovate-lanceolate), acute, somewhat plicate when dry, serrulate all around; costa ending in a dorsal spine about 3/4 up the leaf; cells linear-rhomboidal, short and rhombic at the apex. Dioicous. Setae 10-27 mm. long, reddish or orange-brown, rough; capsules oblong-cylindric, 1.5-2.5 mm. long; operculum 1-1.4 mm. long; peristome teeth brown; cilia of endostome nodulose, in pairs. Spores 9-13 $\mu$, very finely papillose to nearly smooth.–n = 7, 8, 10.

Conard, How to Know the Mosses, (ed. 2) fig. 233a-e. Grout, Mosses with Hand-lens and Microscope, fig. 154. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 53 & (ed. 2) Pl. 58 (as *Oxyrrhynchium*).–**Fig. 848-849.**

On soil and occasionally other substrata in damp, shady places. Europe; eastern Asia; widespread in eastern North America; Arizona and New Mexico; Haiti.

CHEBOYGAN CO.–Gorge of Carp Creek, Iron Bridge (Carp Creek), Mill Creek, Stewart Creek (south of Black Lake).

A plant of relatively wet habitats much resembling *E. pulchellum* but known by its broader leaves and rough setae.

3. **Eurhynchium riparioides** (Hedw.) Rich.–Relatively robust plants in wide, loose, somewhat rigid mats, dark-green or blackish below, often somewhat shiny and green to yellowish or brownish above, irregularly branched; branches elongate, curved-ascending. Stem leaves 1.5-2.5 mm. long, erect to wide-spreading and often ± homomallous, only slightly concave, broadly ovate or oblong-ovate, acute, obtuse, or rounded-obtuse; margins plane, serrulate nearly to the base; costa extending 4/5 or more the leaf length, often projecting as a spine at back; cells green, linear-rhomboidal above, short and broad at the apex. Branch leaves usually only about 1.5 mm. long or less, often ± pinched and twisted at the apex. Autoicous. Setae 12-23 mm. long, orange, becoming reddish with age, smooth; capsules 1.5-2 mm. long, ± curved, oblong-ovoid, becoming constricted below the mouth and at the short neck; peristome teeth dark-brown; endostome pale-brown, the cilia 2-3, well developed, nodose. Spores 13-16 $\mu$, smooth.–n = 6, 8, 10, 11, 12, 20.

Conard, How to Know the Mosses, (ed. 2) fig. 232 (as *E. rusciforme*). Grout, Mosses with Hand-lens and Microscope, fig. 155 (as *E. rusciforme*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 53 & (ed. 2) Pl. 58 (as *Oxyrrhynchium*). Welch, Mosses of Indiana, fig. 141.–**Fig. 850-852.**

On wet rocks in or near brooks, often submerged in swiftly moving water or continually splashed by waterfalls, probably preferring calcareous habitats. Europe, Macaronesia, North Africa,

Asia; British Columbia to California; Arizona, Mexico, and Guatemala; Jamaica and Haiti; northern South America; Newfoundland to Minnesota and Oklahoma, south to Arkansas and North Carolina.

CHEBOYGAN CO.—Mill Creek.

Because of its aquatic habitat, this species has often been treated as a member of the "wet" Amblystegiaceae in the genus *Platyhypnidium.* Although it has an appearance suggestive of *Hygrohypnum,* its true relationship as indicated by structure of gametophyte and sporophyte is clearly with *Eurhynchium pulchellum* and *E. hians.* The plants are larger, coarser, and darker than those of *E. hians* and grow in wetter, often submerged habitats.

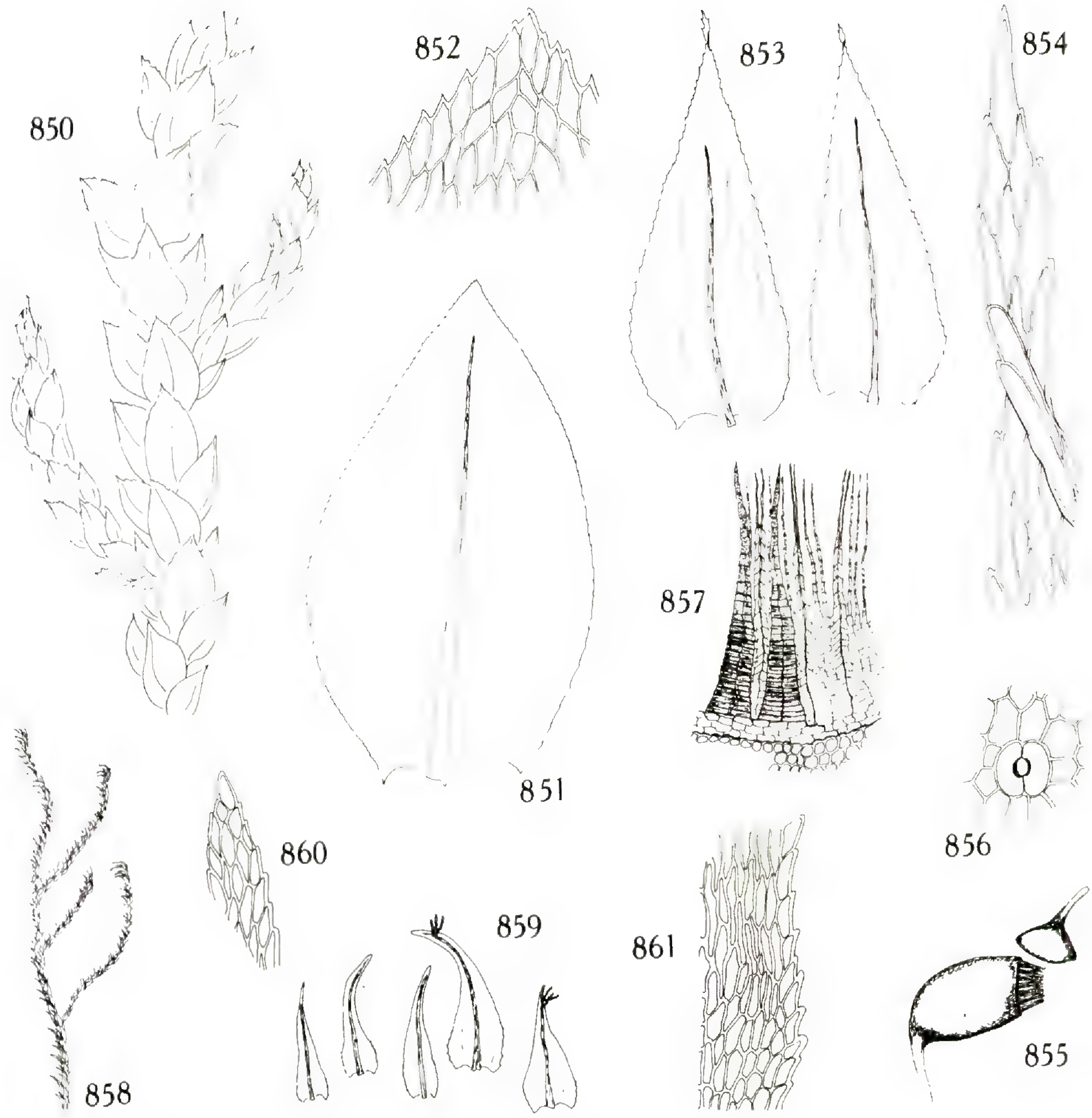
## 6. **Rhynchostegium** BSG

Plants rather small to moderately robust, in soft, pale, green or yellowish, rarely dark-green mats, ± shiny when dry. Stems creeping, irregularly to subpinnately branched. Leaves erect or more often spreading, often somewhat complanate, somewhat concave, smooth, ovate or ovate-lanceolate, short- or long-acuminate; margins somewhat reflexed below, mostly serrulate; costa rarely forked at the tip, ½-¾ the leaf length; cells smooth, linear or oblong-linear, shorter and broader at the base, quadrate to short-rectangular or not differentiated at the basal angles. Perichaetial leaves sheathing at base, abruptly narrowed to a recurved subula. Setae elongate, smooth; capsules strongly inclined to horizontal, ovoid- or oblong-cylindric, ± asymmetric, often constricted below the mouth when dry and empty; annulus differentiated; operculum obliquely long-rostrate from a convex-conic base; stomata in the neck; peristome teeth lance-subulate, cross-striolate below, papillose at the tips, bordered, trabeculate at back; endostome about as long as the teeth, finely papillose, basal membrane high, segments lance-acuminate, perforate along the keel, cilia mostly well developed. Calyptrae naked.—The name refers to the beaked lid of the capsule, really the only reason, and perhaps not a good one, for segregating the genus from *Brachythecium.*

**Rhynchostegium serrulatum** (Hedw.) Jaeg. & Sauerb.—Plants of moderate size, in flat, shiny, bright- or yellow-green mats. Stem and branch leaves similar, usually not crowded, scarcely altered on drying, wide-spreading and somewhat complanate (or occasionally loosely erect), about 2 mm. long (occasionally only 1.5 mm.), oblong-ovate, slenderly acuminate, twisted at the apex; margins plane or erect, distinctly serrulate in the upper 2/3 or nearly to the base; costa slender, ending about 3/4 up the leaf, often ending in a minute and inconspicuous dorsal tooth and often sparsely and minutely toothed near the apex; cells linear-flexuose, not differentiated at the basal angles. Autoicous. Setae flexuose, yellowish or orange-yellow, becoming orange-brown or reddish with age, 10-30 mm. long; capsules oblong-cylindric but becoming narrow, strongly contracted below the mouth, and strongly curved when dry and empty, 1.5-2 mm. long, brown or red-brown; annulus of 2 rows of cells; operculum 1-1.5 mm. long; exostome teeth dark- or red-brown, bordered, trabeculate; endostome pale-yellow, with nodulose cilia in groups of 2-3. Spores 9-11 $\mu$, smooth.—n = 9, 10, 11.

Breen, Mosses of Florida, Pl. 79. Conard, How to Know the Mosses, (ed. 2) fig. 224 (as *Eurhynchium*). Darlington, Mosses of Michigan, fig. 123. Grout, Mosses with Hand-lens and Microscope, Pl. 68 (as *Eurhynchium*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 54, (ed. 2) Pl. 59. Welch, Mosses of Indiana, fig. 142 (as *Eurhynchium*).—**Fig. 853-857.**

On soil, humus, rotten wood, and other substrata in moist or rather dry hardwood forests. Widespread in eastern North America and also in uplands throughout tropical America.




*Eurhynchium riparioides.* 850. Habit. 851. Leaf. 852. Cells at leaf tip.
*Rhynchostegium serrulatum.* 853. Leaves. 854. Cells at leaf tip. 855. Capsule. 856. Stomate. 857. Portion of peristome.
*Rhynchostegiella compacta.* 858. Habit. 859. Leaves. 860. Cells at apex of leaf. 861. Cells at margin of leaf base.

CHEBOYGAN CO.–Gorge of Carp Creek, Colonial Point. EMMET CO.–Pellston Hills, Five Mile Creek.

Best recognized by long-beaked opercula and smooth setae, *R. serrulatum* also differs from various species of *Brachythecium,* most notably forms of *B. rutabulum,* by a combination of characters: pale, wide-spreading, and loosely complanate leaves, serrulate to the base or nearly so and ending in a slender acumen twisted at the tip.

## 7. **Rhynchostegiella** (BSG) Limpr.

Small plants in soft, green or yellowish, dull or shiny mats. Stems creeping, irregularly to subpinnately branched; paraphyllia few, at branch bases. Leaves erect or spreading, rarely somewhat secund, concave or nearly plane, narrowly lanceolate to

ovate-lanceolate, ± long-acuminate; margins plane, entire or ± serrulate; costa ending near the leaf middle to subpercurrent, sometimes projecting at the tip as a dorsal spine; cells smooth, linear or rhomboidal, scarcely differentiated at base, sometimes small and subquadrate at the basal angles. Autoicous; perichaetial leaves ± long-acuminate, not squarrose. Setae elongate, slender and flexuose, red, smooth or papillose; capsules erect to horizontal, oblong-ovoid, nearly symmetric, constricted below the mouth when dry and empty; annulus differentiated; operculum apiculate to long-rostrate from a convex-conic base; exothecial cells mostly ± collenchymatous; peristome teeth lance-subulate, papillose throughout or ± cross-striolate below, papillose at the tips, trabeculate at back; endostome free, about as long as the teeth, basal membrane high, segments lance-acuminate, keeled and perforate, cilia mostly well developed. Calyptrae naked.–A diminutive of *Rhynchostegium*.

**Rhynchostegiella compacta** (C. M.) Loeske–Plants in dense, shiny, green or, more typically, yellow mats. Stems usually crowded and ascending (but sometimes loose and spreading), irregularly branched; branches short, ascending, usually ± curved. Leaves crowded, erect or erect-spreading, often homomallous when dry, 0.6-1.2 mm. long, lanceolate, gradually acuminate, ± decurrent; margins plane, serrulate all around, especially at the base where the teeth are ± spreading or recurved; costa percurrent or nearly so, often indistinct at the midleaf, re-appearing above and frequently bearing subcylindric brood-bodies or rhizoids at back; cells linear-rhomboidal, 5-9:1, sub-quadrate at the basal angles. Setae 8-14 mm. long, smooth, orange-yellow or red; capsules 1.2-1.5 mm. long, suberect or somewhat inclined, somewhat asymmetric, oblong-cylindric from a short neck; operculum obliquely apiculate; stomata in the neck; peristome teeth brown, papillose throughout or somewhat cross-striolate at base; endostome pale, brownish-yellow, the cilia none or short and single. Spores 11-15 $\mu$, very finely papillose.

Conard, How to Know the Mosses, (ed. 2) fig. 222 (as *Amblystegium*). Grout, Mosses with Hand-lens and Microscope, fig. 172 (as *Amblystegium*).–**Fig. 858-861.**

On wet, calcareous cliffs or bark at base of trees in wet woods. Europe; Greenland; Yukon to California, Arizona, and Colorado; Quebec to South Dakota and south to Missouri and Pennsylvania; Mexico.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge, Colonial Point, Grass Bay. MACKINAC CO.–Bois Blanc Island.

Somewhat like an *Amblystegium* in size and appearance but softer and with longer leaf cells (clearly like the Brachytheciaceae). The long costa disappears in the acumen near the leaf apex, and the margins are serrulate in an interesting way, with abrupt, recurved, and paired teeth near the leaf base. The common occurrence of brood-bodies at the back of the leaf tips is an additional aid in identification.

## 8. **Pleurozium** Mitt.

Rather robust plants in loose, light-green or yellowish, ± shiny mats. Stems erect-ascending from a decumbent base, pinnately branched; branches loosely julaceous, blunt or tapered; paraphyllia none. Leaves loosely imbricate, very concave, obscurely wrinkled-plicate when dry, broadly oblong-ovate, rounded at the apex and generally appearing recurved-apiculate because of abruptly incurved margins, somewhat decurrent; margins plane or reflexed near the base, broadly incurved above, crenulate to serrulate at the apex; costa short and double; upper cells linear, smooth; cells at the insertion thick-walled, porose, and orange, the alar cells shortly oblong, with thick,

orange walls, in rather small, triangular, often concave groups. Branch leaves shorter and narrower. Dioicous; perichaetial leaves erect, elongate, oblong-lanceolate, acuminate. Setae elongate, red or red-yellow, flexuose, smooth; capsules strongly inclined to horizontal, curved, oblong-cylindric from a tapered neck, smooth; annulus none; operculum conic or convex-conic, acute; stomata small, near the junction of seta and urn; peristome teeth brown or brownish-yellow, finely papillose throughout (or only indistinctly transversely papillose-striolate below), bordered; endostome pale-brownish, finely papillose, with a high basal membrane, keeled and gaping segments, and well-developed cilia in groups of 2-3. Calyptrae naked.—The name presumably refers to the branches produced on either side of a suberect stem (in a loosely pinnate arrangement). Because the costa is short and double and the alar cells noticeably differentiated, *Pleurozium* is often placed in the Entodontaceae. However, the aspect—so like *Pseudoscleropodium*— and the nature of the capsule suggest a closer tie to the Brachytheciaceae.

**Pleurozium schreberi** (Brid.) Mitt.—Plants about 7-16 cm. high. Setae 20-43 mm. long; capsules 2-2.5 mm. long; cilia of endostome nodulose or rarely ± appendiculate. Spores 11-20 $\mu$, very finely papillose.—n = 5, 10.

Conard, How to Know the Mosses, (ed. 2) fig. 269 (as *Calliergonella*). Grout, Mosses with Hand-lens and Microscope, fig. 166 (as *Calliergon*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 44, (ed. 2) Pl. 48 (as *Hypnum*).—**Fig. 862-865.**

On humus, soil, and other substrata, usually in dry, open woods, but also in bogs or wet, coniferous woods. Circumpolar; Costa Rica; northern South America; across Canada, Alaska, and the northern United States, south through the Great Lakes area and Virginia.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Bryants Bog, Colonial Point, Vincent Lake, Livingston Bog, Mud Lake, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.—Arnott Lake, Galloway Bog, Maple River Township, Pleasantview Swamp, Stutsmanville, Carp Lake, Wycamp Lake, Cecil Bay, Big Stone Bay, Conway Bog. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Bush Bay, Epoufette, Ozark, Little Dollar Lake, Caffey Corner, Hendricks, Prentiss Bay. PRESQUE ISLE CO.—Evergreen Beach, Hammond Bay, Huron Beach, Mast Point, Ocqueoc River, Clinton Lake, Kelsey Pond, Loon Lake.

Linnaeus used the name *Hypnum parietinum* for this common northern moss, in reference to its use in stopping chinks in the walls of houses in Scandinavia. Braithwaite reported that it had been used in a similar way in shelters on ancient island refuges in lakes or bogs in Great Britain. The plants can be recognized in the field by red stems visible through semi-transparent leaves. (The leaves are light-green or yellowish with something of a grayish overcast when dry). The species has been placed in *Hylocomium,* and poorly branched forms of *H. splendens* can indeed be confused with *Pleurozium.* The abundant presence of paraphyllia in *Hylocomium* is the best means of establishing the identity of doubtful specimens.

The widespread occurrence of *Pleurozium schreberi* in the Northern Hemisphere, and its disjunction in Central and South America are difficult to understand, as it seldom fruits and has no obvious mode of vegetative reproduction. The mystery is heightened, as noted by Watson (in *Structure and Life History of Bryophytes*), by the fact that one rarely sees young growth stages as evidence of recent establishment or active dispersal.

Newton (Trans. Brit. Bryol. Soc. 6(2): 230-243. 1971) found a measurable difference in the size of the interphase heterochromatin in male and female plants of *Mnium undulatum,* enabling him to sort out sterile plants as to sex potential. By determining sex in this way, he showed that male and female plants are intermingled more often than not (in a ratio of 1.3:1), but male plants are decidedly fewer (1:5.6 or

862

863

864

865

*Pleurozium schreberi.* 862. Habit. 863. Leaves. 864. Cells of alar region. 865. Capsule.

6.5). Fertilization is limited by the fact that not all male plants produce inflorescences and distance is also a factor: The distance of a fertilized female plant from the nearest male was normally only 2.5-12 cm. (in one instance 20 cm.)

Hague and Welch (Bryol. 54: 214-215. 1951) attributed scarcity of fruits in *Bryoxiphium norvegicum* to the fact that the sexes are nearly always found segregated and inflorescences often lacking anyway. In a single fruiting specimen seen (from the Wisconsin Dells), they found only archegonia.

Bedford's study of sex distribution in colonies of *Climacium dendroides* (Northw.

Nat. 13: 213-221. 1938) is also worthy of reference, as is a recent study of *Rhytidiadelphus triquetrus* by Reimann (Lindbergia 1: 219-224. 1973).

*Pleurozium schreberi* is one of the few mosses recorded from every vice-county in the British Isles. There, the scarcity of sporophytes has been correlated with a rarity of male plants by Longton & Greene (Ann. Bot. 33: 107-126. 1969). Fruiting specimens were usually found where male and female plants grew intermixed. Fruiting was induced in nature by transplanting from one area to another, in one instance, between male and female colonies growing only 10 meters apart. In another study, Longton & Greene (Ann. Bot. 33: 83-105. 1969) reported details of the life cycle in Great Britain, where spores are shed nine to 12 months after fertilization.

Additional use of sex-ratio differences in *Mnium* are recorded by Newton (Ann. Bot. 36: 163-178. 1922).

Uggla (Acta Phytogeogr. Suec. 41: 1-116. 1958) found that *Pleurozium schreberi* and *Hylocomium splendens* often lack connections with the substrate and are therefore usually completely consumed by forest fires. In northern Finland, they colonize burns only after 30-40 years and then compete well with low-growing Cladonias and sods of *Ceratodon purpureus, Polytrichum juniperinum,* and *P. piliferum.* The *Polytricha* survive fires better because of penetration of mineral soil by rhizoids.

## ENTODONTACEAE

Plants in loose, ± shiny mats or tufts. Stems creeping or sometimes erect-ascending (very rarely pendent), irregularly to pinnately branched; branches generally julaceous, sometimes ± flattened. Leaves crowded in many rows, usually appressed at least when dry, sometimes ± complanate, mostly symmetric, of various shapes; costa single and ± elongate (but never percurrent), very short and double, or lacking; cells linear or oblong-linear, rarely narrowly elliptic, smooth, mostly quadrate and oblate-rectangular at the basal angles, sometimes in many oblique rows, or rarely undifferentiated. Inflorescences lateral; perichaetial leaves differentiated. Setae elongate; capsules mostly erect and symmetric, mostly cylindric; annulus present or lacking; operculum conic and often rostrate; peristome usually double (rarely the endostome lacking), the teeth 16, papillose or variously striolate, rarely smooth or irregularly thickened, the trabeculae lacking to well developed; endostome consisting of a mostly low, keeled basal membrane and keeled, often narrowly perforate segments, cilia lacking or rudimentary. Spores spherical. Calyptrae cucullate, mostly naked.

### **Entodon** C. M.

Slender to moderately robust plants in green, yellow, or golden-brown, flat mats or loose tufts. Stems creeping to ascending, irregularly to subpinnately branched; branches short, blunt or acute, spreading, terete or ± flattened. Leaves crowded, concave, often ± complanate, oblong-ovate or oblong-lanceolate, blunt or acute to acuminate; margins erect or somewhat reflexed near the base, often serrulate at the apex; costa very short and double or lacking; cells linear above, shorter and broader at the base, hyaline and laxly quadrate in rather well-marked alar groups. Perichaetial leaves elongate, acuminate from a ± sheathing base, erect or spreading. Setae rather short to elongate, smooth, reddish or yellow; capsules erect and symmetric, cylindric, brown; annulus present or lacking; operculum usually obliquely rostrate; stomata few, at extreme base of the urn; peristome teeth inserted somewhat below the mouth, brown or red-brown, lanceolate, papillose or variously striolate or rarely smooth, not or narrowly bordered; endostome usually about as long as the teeth, with a very low

basal membrane, linear, ± keeled segments, the cilia none (or exceedingly rudimentary). Calyptrae naked.—The name refers to the teeth of the peristome which are within the capsule, *i.e.*, inserted below the mouth. Generic characteristics include virtually ecostate leaves with laxly quadrate alar cells and long, narrow, erect capsules with a double, non-hypnaceous peristome. Color of seta (whether reddish or yellowish) and surface markings on the peristome are of fundamental importance in classification of the genus.

Stem and branches distinctly flattened; leaves complanate; peristome teeth papillose
1. *E. cladorrhizans*

Stems and branches terete; leaves not complanate; peristome teeth smooth or nearly so
2. *E. seductrix*

1. **Entodon cladorrhizans** (Hedw.) C. M.—Bright- or yellow-green plants, sometimes tinged with golden-brown. Stems prostrate, subpinnately branched; both stems and branches strongly flattened. Stem leaves erect or erect-spreading and complanate, about 2 mm. long, broadly oblong-ovate, acute; margins serrulate (and often notched) at the apex. Branch leaves smaller. Autoicous. Setae 7-20 mm. long, orange-brown; capsules 2-3 mm. long, dark-brown; annulus of 2-3 rows of cells, persistent; operculum high-conic or obliquely rostrate; peristome teeth finely papillose (or occasionally ± striolate), slightly bordered, often perforate above; segments smooth or slightly and obscurely roughened. Spores 13-20 $\mu$, faintly roughened to finely papillose.

Breen, Mosses of Florida, Pl. 82. Conard, How to Know the Mosses, (ed. 2) fig. 290. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 32, (ed. 2) Pl. 36.—**Fig. 866-869.**

On rotten wood, leaf litter, and bases of trees in shady places. British Columbia and Alberta; widespread in eastern North America.

CHEBOYGAN CO.—Colonial Point, Trout Creek, Cheboygan, Black River, Black Lake. EMMET CO.—Harbor Springs.

Recognized by shiny, erect-spreading, complanate leaves.

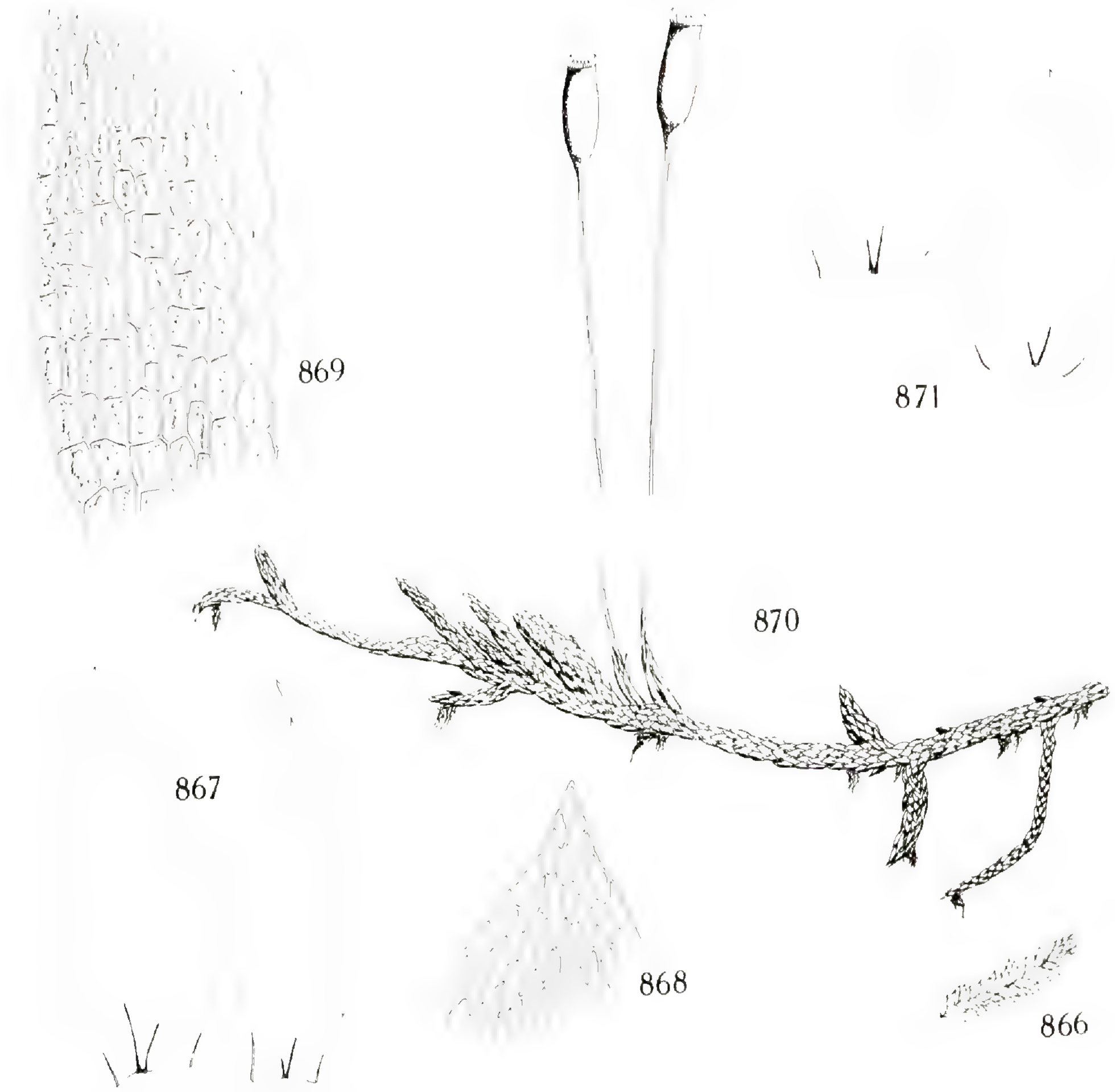
2. **Entodon seductrix** (Hedw.) C. M.—Plants in green, yellowish, or brownish-tinged mats. Stems creeping, subpinnately branched; stems and branches terete and sometimes slightly flattened. Leaves concave, imbricate, 1-2 mm. long, oblong-ovate or elliptic, abruptly acute to apiculate; margins entire or slightly serrulate at the apex. Autoicous. Setae 5-16 mm. long, red or red-brown; capsules 2-3.5 mm. long, dark-brown, usually somewhat wrinkled-striate when dry and empty; annulus of 2-3 rows of cells, persistent; operculum stoutly and obliquely rostrate; peristome teeth smooth or faintly and irregularly roughened, distinctly bordered; endostome segments smooth. Spores 13-21 $\mu$, finely papillose.—n = 11.

Breen, Mosses of Florida, Pl. 81. Conard, How to Know the Mosses, (ed. 2) fig. 286a-g. Darlington, Mosses of Michigan, fig. 128. Grout, Mosses with Hand-lens and Microscope, fig. 205. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 33, (ed. 2) Pl. 37. Welch, Mosses of Indiana, fig. 215.—**Fig. 870-871.**

On rotten wood and bases of trees in shady, often rather dry places. Widespread in eastern North America.

CHEBOYGAN CO.—Camp Knight (Douglas Lake), Riggsville, Black Lake. EMMET CO.—Pellston Dunes, Larks Lake.

Shiny and attractive (though scarcely seductive), this species is distinguished from *E. cladorrhizans* by its julaceous stems and branches.




*Entodon cladorrhizans*. 866. Habit of branch. 867. Leaves. 868. Upper cells of leaf. 869. Cells in alar region.

*Entodon seductrix*. 870. Habit. 871. Leaves.

## PLAGIOTHECIACEAE

Plants rather small to moderately robust, in ± shiny, loose or dense mats. Stems mostly creeping, irregularly or rarely pinnately branched; branches ± flattened; paraphyllia none. Stem and branch leaves similar, lanceolate to broadly ovate or elliptic, obtuse or acute to acuminate, sometimes clearly decurrent, ± concave, ± complanate, obliquely inserted, the dorsal and ventral leaves mostly symmetric and erect or appressed, the lateral leaves often larger, ± asymmetric and inflexed at the base on alternating sides; costa single and ± elongate, short and double, or lacking; cells linear, oblong-linear, or sometimes oblong-rhombic, mostly smooth and chlorophyllose, sometimes clearly differentiated at the basal angles and quadrate or shortly oblate-oblong. Perichaetia lateral; perichaetial leaves rather small, erect, acuminate from a ± sheathing base. Setae ± elongate, smooth; capsules erect or inclined to horizontal, symmetric or nearly so; annulus mostly present; operculum convex-conic, sometimes obliquely rostrate; peristome double, the 16 teeth lance-acuminate, mostly cross-striolate below, bordered, trabeculate; endostome free, the basal membrane high,

segments broad and keeled, cilia present or lacking. Spores spherical. Calyptrae cucullate, smooth, naked.

## Plagiothecium BSG

Plants slender to medium-sized, in loose or dense, usually flat, green or yellowish, shiny mats. Stems creeping or crowded and ascending, freely branched; cortical cells of stems and branches large; pseudoparaphyllia none. Stem and branch leaves similar, mostly strongly complanate, often asymmetric, oblong-ovate to ovate-lanceolate, acute or acuminate, decurrent; margins often revolute, sometimes nearly to the apex, entire or sparsely serrulate at the apex; costae double, unequal, frequently reaching 1/3-1/2 the leaf length, sometimes very short or lacking; cells smooth, linear-flexuose or long-rhomboidal, shorter and broader at the base, laxly oblong in a few rows at the basal margins in rather poorly differentiated, decurrent alar groups. Perichaetial leaves moderately enlarged, sheathing, with somewhat spreading tips. Setae elongate, becoming reddish with age; capsules suberect and symmetric to strongly inclined or horizontal and asymmetric, oblong-cylindric from a short neck, smooth or ± longitudinally wrinkled-plicate when dry and empty; annulus present; operculum conic, stoutly and obliquely apiculate to rostrate; stomata in the neck; peristome teeth pale-yellowish and cross-striolate below, hyaline and papillose above, bordered, trabeculate; endostome hyaline, papillose, with a high basal membrane, keeled segments (not or very narrowly perforate), and nodulose cilia in groups of 2-3 (or occasionally single, rarely lacking or rudimentary).—Named for the obliquely inclined capsules. The outstanding feature of the genus is the alar cells which are somewhat differentiated in narrow, decurrent groups. The leaves are generally complanate.

1. Leaves symmetric or nearly so, typically concave, not or only loosely and irregularly complanate (and if so, shrunken, ± contorted, and scarcely overlapping when dry) 1. *P. cavifolium*
1. Leaves asymmetric, flat, distinctly complanate
   2. Leaf cells about 5-7 μ wide, linear-flexuose; capsules suberect, symmetric or nearly so, smooth, and not contracted below the mouth when dry 2. *P. laetum*
   2. Leaf cells broader, about 10-13 μ wide, long-rhomboidal; capsules strongly inclined to horizontal, curved and asymmetric, contracted below the mouth and usually ± wrinkled-plicate when dry 3. *P. denticulatum*

1. **Plagiothecium cavifolium** (Brid.) Iwats.—Plants of medium size, in ± shiny, yellowish to golden or sometimes bright-green mats. Stems and branches crowded, ascending, and terete-foliate or prostrate and loosely and irregularly oomplanate-foliate (often tapered and ± complanate-foliate at the branch tips. Small, cylindric gemmae sometimes produced in leaf axils or on leaves. Leaves crowded and erect or sometimes fairly remote, irregularly complanate, and somewhat contorted when dry, usually concave, 1.5-3 mm. long, symmetric, ovate-lanceolate to oblong-ovate, abruptly narrowed to a short, acute, often recurved apex or gradually narrowed to a short or rather long acumen; margins often narrowly revolute near the base, sometimes nearly to the apex, entire or occasionally sparsely serrulate at the tip; costa with 1 branch usually 1/3-1/2 the leaf length; cells long-rhomboidal, about 10-13 μ wide. Dioicous. Setae 9-20 mm. long; capsules suberect and symmetric or somewhat inclined and ± asymmetric, 1.5-2.5 mm. long, smooth; annulus revoluble in fragments; operculum stoutly rostrate; cilia of endostome 2-3. Spores 9-13 μ, minutely roughened or nearly smooth.—n = 9+1, 10, 11+1, 20.

Breen, Mosses of Florida, Pl. 89 (figs. 6-10), as *P. sylvaticum*. Grout, Moss Flora of North America 3: Pl. 39C (as *P. roeseanum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 47 &

(ed. 2) Pl. 51 (as *P. sylvaticum*), Welch, Mosses of Indiana, fig. 209 (as *P. roeseanum*).–**Fig. 872-874.**

On shaded soil or humus (often overlying rocks or cliffs), sometimes on rotten wood or bases of trees. Europe and Asia; Newfoundland to Minnesota and south to Georgia and Arkansas; Alaska and the Aleutians.

CHEBOYGAN CO.–Burt Lake, Colonial Point, Polypody Bluff and Fairy Island (both at Douglas Lake), Livingston Bog, Mud Lake, Mullet Lake, Black Lake. EMMET CO.–Levering, Arnott Lake, Maple River Dam, Pleasantview Swamp, Middle Village, Cross Village, Wycamp Creek. MACKINAC CO.–Cut River, Ozark, Prentiss Bay. PRESQUE ISLE CO.–Loon Lake, Rainy Lake.

*Plagiothecium cavifolium* is a common species of great variability. The branches may be terete-foliate in a form commonly called *P. roeseanum* BSG or, in the form generally referred in this country, through error, to *P. sylvaticum* (Brid.) BSG, somewhat to strongly flattened, with leaves loosely complanate and somewhat shrunken and scarcely overlapping when dry. The plants, characteristically yellowish, are not as glossy as those of *P. denticulatum* or *P. laetum.*

**Plagiothecium latebricola** BSG, a rare species of swamps and meadows, might show up in our area in swampy habitats (on bases of rotten stumps or on old *Carex* or fern tussocks, for example). The plants are very small and delicate, with erect-spreading, not or slightly and loosely complanate, nearly symmetric leaves about 0.8-1.2 mm. long, gradually narrowed to a slender, acute tip which is not recurved. The species has been collected in Muskegon and Washtenaw Counties.

Such names as *Plagiothecium latebricola* and *Campylostelium saxicola* are troublesome to most users of botanical Latin, as the specific epithets seem to be out of agreement with the neuter generic names. But the epithets are not adjectives, but nouns in apposition.

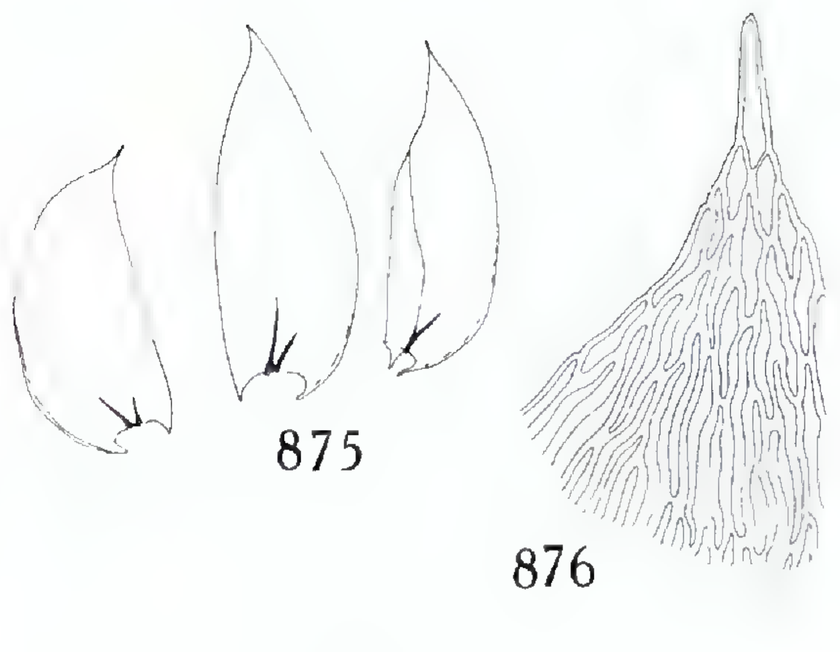
2. **Plagiothecium laetum** BSG–Rather small plants in very glossy, bright- or yellow-green to golden mats. Stems and branches prostrate and very flat. Leaves overlapping, spreading and strongly complanate, sometimes subsecund at the tips, 1.2-1.5 (rarely 2) mm. long, asymmetric, oblong, oblong-ovate, or oblong-lanceolate, acute or acuminate; margins plane or narrowly revolute, sometimes nearly to the apex; costa with 1 branch often 1/3-1/2 the leaf length; upper cells linear-flexuose, about 5-7 $\mu$ wide. Autoicous. Setae 8-16 (rarely 20) mm. long; capsules suberect (or rarely strongly inclined), symmetric or nearly so, 1.5-2 mm. long, pale- or yellow-brown, smooth; annulus revoluble in fragments; operculum stoutly rostrate; çilia of endostome 1-3. Spores 9-12 $\mu$, smooth or nearly so.–n = 10, 10+1, 11.

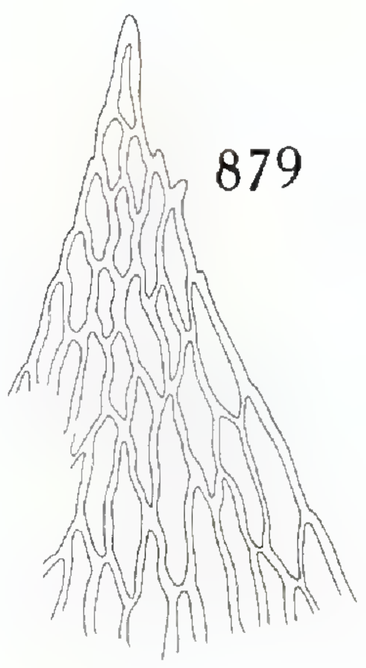
Grout, Moss Flora of North America 3: Pl. 40 above.–**Fig. 875-876.**

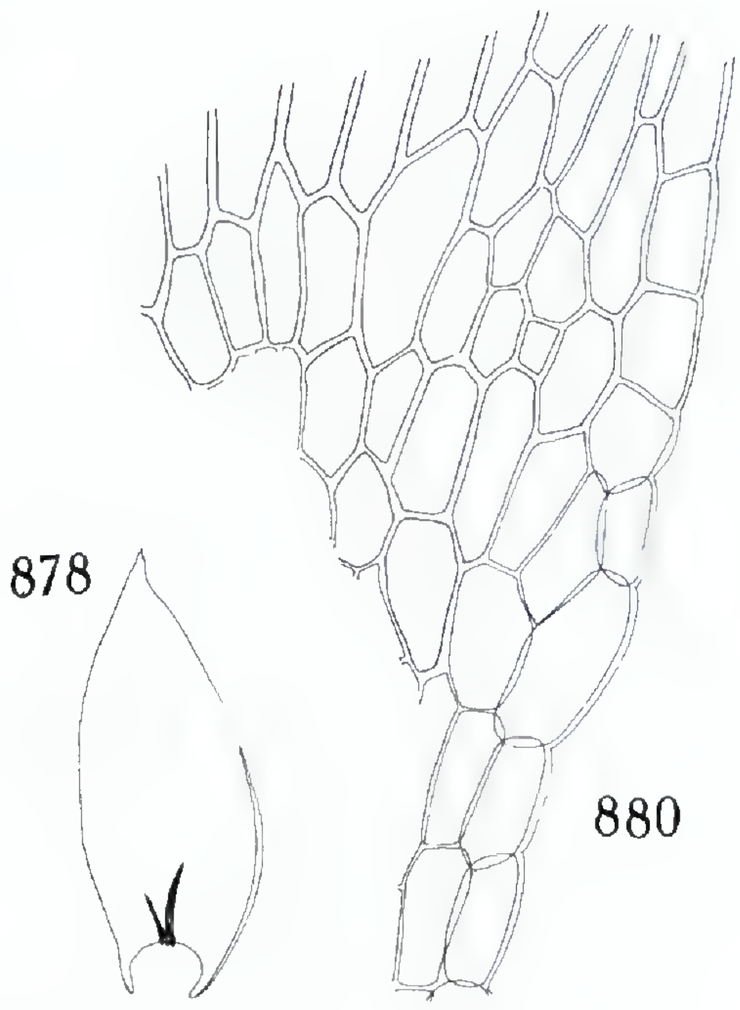
Usually in coniferous woods, particularly on humus or soil of steep banks or overlying rocks and cliffs, also on rotten wood and bases of trees. Europe; Alaska to California and New Mexico; Newfoundland to Manitoba, south to Iowa and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Ingleside, Bryants Bog, Vincent Lake, Mud Lake, Little Lake 16. EMMET CO.–Pellston Hills, Arnott Lake, Carp Lake, Wycamp Lake, Cross Village, Middle Village, Five Mile Creek, Big Stone Bay. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, Prentiss Bay, Cut River, Hendricks. PRESQUE ISLE CO.–Lamprey Experiment Station, Mast Point.

*Plagiothecium laetum* is common in flat, very glossy mats on steep, wooded banks and often on soil, humus, or bark at the bases of trees. As in *P. denticulatum,* the leaves are crowded and very complanate; indeed, the species is in many ways






*Plagiothecium cavifolium.* 872. Leaves. 873. Cells at leaf tip. 874. Brood-bodies.
*Plagiothecium laetum.* 875. Leaves. 876. Cells at leaf tip.
*Plagiothecium denticulatum.* 877. Habit. 878. Leaf. 879. Cells of leaf tip. 880. Decurrent alar cells.

merely a small edition of *P. denticulatum,* one of its synonyms being *P. denticulatum* var. *tenellum* BSG. It is distinct, however, in having upper leaf cells narrower (5-7 $\mu$ wide) and linear-flexuose and capsules suberect, nearly symmetric, and not contracted below the mouth when dry, and it grows in drier niches.

3. **Plagiothecium denticulatum** (Hedw.) BSG—Plants light- or, more often, dark-green, shiny. Stems and branches flattened or somewhat ascending. Leaves usually crowded and overlapping, wide-spreading and complanate, rarely somewhat contorted when dry, 1.5-3 mm. long, asymmetric, oblong-ovate, broadly acute to broadly acuminate; margins sometimes plane but usually clearly revolute nearly to the apex, sparsely serrulate at the tip; costa with 1 branch usually 1/3-1/2 the leaf length; upper cells long-rhomboidal, about 10-13 $\mu$ wide. Small, cylindric, 3-7-celled brood-bodies sometimes produced near the leaf tips. Autoicous (or sometimes dioicous). Setae 15-30 mm. long; capsules strongly inclined to horizontal, narrowly oblong-cylindric, curved and asymmetric, 1.5-3 mm. long, brown, smooth or ± wrinkled-plicate, contracted below the mouth when dry; annulus revoluble in fragments; operculum stoutly rostrate; cilia of endostome 2-3. Spores 9-11 $\mu$, smooth.—n = 10, 11, 20, 25.

Conard, How to Know the Mosses, (ed. 2) fig. 294. Grout, Mosses with Hand-lens and Microscope, Pl. 84. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 48, (ed. 2) Pl. 53. Welch, Mosses of Indiana, fig. 207.–**Fig. 877-880.**

In wet woods, often in swamps, on rotten wood, bases of trees, soil, or humus (sometimes on soil or humus overlying rocks or cliffs). Europe, Macaronesia, Asia, Australia, and New Zealand; Alaska to California and New Mexico; Newfoundland to Manitoba and south to Illinois and North Carolina; Mexico.

CHEBOYGAN CO.–Iron Bridge, Ingleside, Smiths Bog, Colonial Point, Mud Lake. EMMET CO.–Carp Lake, Stutsmanville, Wycamp Lake. MACKINAC CO.–Bois Blanc Island, McNamara Pond.

*Plagiothecium denticulatum* has shiny, crowded, complanate leaves with a few small and irregular teeth at the very tips. The leaf margins are usually distinctly recurved. As compared with flattened forms of *P. cavifolium,* the leaves are more crowded, more complanate, more shiny, and more broadly pointed. In contrast to *P. laetum* (which is much more common locally), it has broader, long-rhomboidal upper leaf cells (about 10-13 rather than 5-7 $\mu$ wide), and the capsules are curved-asymmetric and contracted below the mouth when dry. It also grows in wetter habitats, on humus at the swampy margins of pools, for example, whereas *P. laetum* characteristically occurs on soil of steep banks or on bark at base of trees.

## SEMATOPHYLLACEAE

Plants slender to moderately robust, in soft or rather rigid mats, green or yellowish to yellow-brown or golden, often shiny. Stems creeping or sometimes erect-ascending, irregularly to subpinnately branched; paraphyllia mostly lacking. Stem and branch leaves mostly uniform, crowded in many rows but often ± complanate, often homomallous or distinctly secund, mostly symmetric, variously shaped; costa very short and double or lacking; cells mostly long-rhomboidal or linear, smooth or variously papillose, nearly always clearly differentiated at the basal angles (often abruptly and conspicuously inflated at the extreme angles in 1 or more transverse rows). Perichaetia lateral; perichaetial leaves differentiated. Setae elongate, smooth or sometimes ± papillose; capsules inclined to pendulous and ± asymmetric or rarely erect and symmetric, ovoid- or oblong-cylindric, smooth; annulus usually lacking; operculum convex or conic, usually rostrate; exothecial cells frequently collenchymatous; peristome mostly double, the teeth 16, mostly lance-subulate, cross-striolate below (or only rarely smooth or papillose), sometimes furrowed along the median line, usually strongly trabeculate at back; endostome (rarely lacking) nearly always free, about as long as the teeth or rarely much longer, basal membrane mostly high, segments lance-subulate and keeled (or sometimes filiform, rarely short and broad), cilia usually present. Spores spherical. Calyptrae cucullate or rarely mitrate, naked.

Leaves erect-spreading and somewhat complanate, not or sometimes very slightly falcate at the tips; alar cells subquadrate in several rows ..... 1. *Heterophyllium*
Leaves spreading and loosely complanate, falcate-secund at the tips; alar cells inflated and oblong in 1 row ..... 2. *Brotherella*

### 1. **Heterophyllium** (Schimp.) Kindb.

Plants medium-sized or moderately robust, in green or yellowish to brownish, somewhat shiny, extensive, flat mats. Stems creeping, subpinnately branched; branches horizontal, acute, straight or curved, obscurely flattened; paraphyllia few, at the bases of branches. Stem and branch leaves sometimes ± differentiated, erect or erect-spread-

ing, often ± secund, concave, lanceolate to ovate, short- to long-acuminate; costa very short and double or none; cells smooth, linear, yellowish at the insertion, subquadrate and somewhat inflated with moderately thickened walls in several rows at the basal angles forming small but well-marked, concave, hyaline or yellowish alar groups. Perichaetial leaves clearly differentiated, elongate. Setae elongate, smooth; capsules suberect or inclined, ± curved, cylindric; annulus ± differentiated; operculum conic, apiculate or rostrate; exothecial cells not collenchymatous; peristome teeth lance-acuminate, cross-striolate and bordered below, papillose above, trabeculate at back, with a zig-zag median line; endostome hyaline or yellowish, papillose, the basal membrane high, segments broad and keeled, not or narrowly perforate, cilia ± well developed. Calyptrae cucullate.–The name alludes to the somewhat dimorphous leaves of stems and branches and is not appropriate to our species which is more properly placed in the Hypnaceae as *Callicladium haldanianum* (Grev.) Crum, Bryol. 74: 167. 1972.

**Heterophyllium haldanianum** (Grev.) Kindb.–Plants bright-green, yellowish, or brownish. Branches rather short, unequal, tapered, straight or somewhat curved, especially at the tips, somewhat flattened. Stem and branch leaves similar, scarcely altered on drying, erect or erect-spreading, often slightly secund (particularly near the ends of branches), somewhat flattened but not distinctly complanate, about 1-1.7 mm. long, ovate or ovate-lanceolate, gradually narrowed to a short or fairly long acumen; margins plane, entire; cells long-linear, flexuose, somewhat shorter and broader at the insertion; subquadrate alar cells well marked, often yellow-brown. Autoicous. Setae 16-32 mm. long, brown to red, slender, flexuose; capsules suberect to inclined, narrowly cylindric, somewhat curved (especially below the mouth), 1.7-3 mm. long; operculum stoutly and obliquely rostrate from a conic base; peristome teeth yellow-brown; cilia of endostome single, short to elongate, fragile. Spores 12-16 $\mu$, finely papillose.–n = 11, 20+2, 22.

Conard, How to Know the Mosses, (ed. 2) fig. 275. Darlington, Mosses of Michigan, fig. 132. Grout, Mosses with Hand-lens and Microscope, fig. 191 (as *Hypnum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 46, (ed. 2) Pl. 50 (as *Stereodon haldanianus*). Welch, Mosses of Indiana, fig. 199.–**Fig. 881-884.**

Usually on logs or stumps, in both wet and dry forests, often in partial shade (at the edges of woods or in brushy thickets), also occasionally on bark at base of trees. Europe; Asia; widespread in eastern North America, from Nova Scotia to Manitoba, south to Missouri and Virginia.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Sedge Point, Colonial Point, Vincent Lake, Smiths Bog, Wolffs Bog, Bryants Bog; Livingston Bog, Mud Lake, Duncan Bay, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.–Maple River, Pleasantview Swamp, Levering, Arnott Lake, Pellston Hills, Wycamp Lake, Big Stone Bay. MACKINAC CO.–Bois Blanc Island, St. Martins Point, McKays Creek, Prentiss Bay, Cut River, Gros Cap, Epoufette, Ozark, Hendricks, Little Dollar Lake. PRESQUE ISLE CO.–Ocqueoc River, Lamprey Experiment Station, Clinton Lake.

This species has considerable character because of the short, tapered, and somewhat flattened branches (resembling small swords) and also because of the curved but nearly erect capsules.

The hygroscopic movements of peristome teeth result from the unequal deposition of material on adjacent walls of two peristomial layers. Each tooth reacts to moisture as a bimetallic strip reacts to temperature. The endostome consists of a single layer of material and is therefore not hygroscopic. It is a common oversimplification to say that peristome teeth spread outward when dry and thus allow spores to be dispersed when atmospheric conditions are suitably dry. As Patterson (Bryol. 56: 157-159. 1953) pointed out, in many (but not all) epiphytic mosses, the peristomes

*Heterophyllium haldanianum.* 881. Habit. 882. Leaves. 883. Alar cells. 884. Capsule.

open when wet. According to Lazarenko (Bryol. 60: 14-17. 1957), it is only in a small group of epiphytic mosses with reduced double peristomes, such as *Orthotrichum*, that the teeth spread outward under dry conditions. In a much larger group of epiphytes, those with perfect double peristomes, the teeth bend inward both wet and dry, and the peristome is closed except at a time of change from wet to dry or vice versa, *i.e.*, at the beginning and end of rain or heavy dew. Dispersal of spores under such conditions insures adherence to a substrate and sufficient moisture for germination. These mosses are thus protected from the hazards of long-range dispersal. (Of course, some spores washed down to lower parts of the same tree may be redistributed by air currents during dry periods.) As shown by Lazarenko (*loc. cit.*), the double peristome of *Heterophyllium* actually prevents the escape of spores under both dry and wet conditions. However, the teeth regularly break off in response to hygroscopic changes (after only 10-20 movements), and the spores are then salted into the air currents as though from a gymnostomous capsule.

Other references on spore dispersal in mosses: Goebel (Flora 80: 459-486. 1895), Pfaehler (Bull. Soc. Vaudoise Sci. Nat. 40: 41-132. 1904), Sayre (Gard. Jour. 2: 51-53. 1952), Steinbrinck (Flora 84: 131-158. 1897), Ingold (*Spore Discharge in Land Plants,* 1939; Trans. Bot. Soc. Edinb. 38: 76-88. 1959; *Spore Liberation,* 1965).

Other information on dispersal mechanisms is given in discussions on *Splachnum, Buxbaumia,* and *Tetraphis.* The airgun method of explosively discharging spores from dried capsules of *Sphagnum* also deserves mention. The effectiveness of such mechanisms are discussed by Crum (Jour. Hattori Bot. Lab. 35: 269-298. 1972.)

## 2. **Brotherella** Loeske *ex* Fl.

Plants slender to medium-sized, in green, yellowish, or rarely brownish-green mats, ± glossy. Stems creeping, freely branched. Stem and branch leaves similar, crowded, ± complanate and secund to falcate-secund, concave, oblong-ovate or oblong-lanceolate, slenderly acuminate; margins recurved below, serrulate above, ecostate; cells smooth, long-rhomboidal or linear, yellow at the insertion, rather large, oblong, inflated, and hyaline or yellow in a single transverse row at the basal angles (with a few small, isodiametric cells above them). Perichaetial leaves plicate, subulate-acuminate, toothed above. Setae elongate; capsules mostly ± inclined, oblong-ovoid and somewhat asymmetric to subcylindric; annulus persistent; exothecial cells not collenchymatous; operculum short- to long-rostrate; peristome teeth subulate-acuminate, with a zig-zag median line, cross-striolate, trabeculate; endostome about as long as the teeth, free, yellow, basal membrane rather high, segments keeled and often perforate, cilia ±rudimentary. Calyptrae cucullate.–Named for the great Finnish bryologist, V. F. Brotherus, author of the Musci in Engler and Prantl's *Die natürlichen Pflanzenfamilien.*

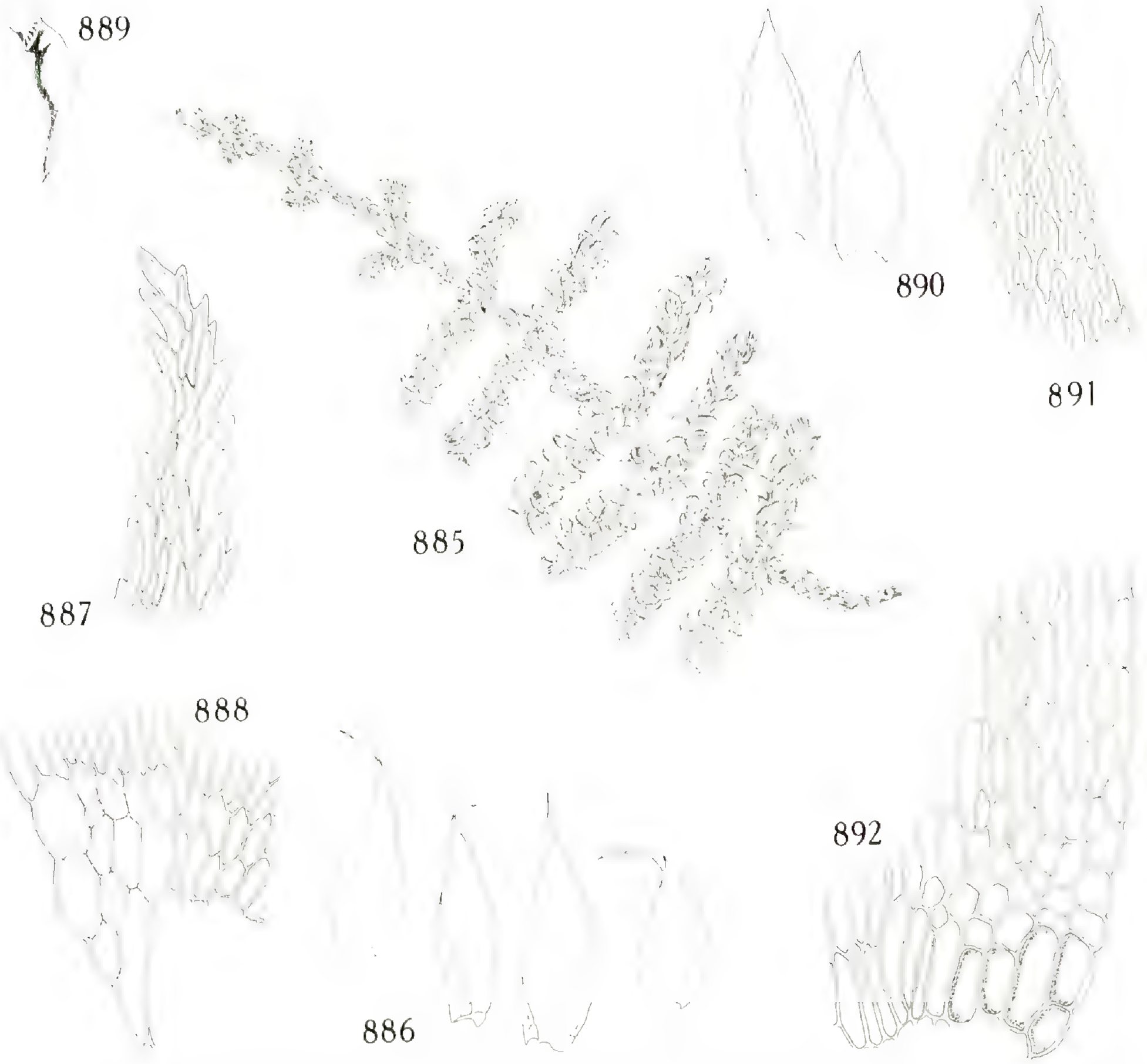
**Brotherella recurvans** (Mx.) Fl.–Very shiny, green, yellow, or golden plants. Stems subpinnately branched. Leaves 1-1.4 mm. long, erect-spreading and loosely complanate with falcate-secund tips or more clearly falcate-secund, oblong-ovate or sometimes oblong-lanceolate, slenderly acuminate; margins sharply serrulate above; cells linear above, shorter, broader, and yellow at the insertion with about 4-8 cells at the basal angles conspicuously inflated and yellowish in a single transverse row, with 1-2 or more rows of moderately inflated, usually hyaline cells above them. Dioicous. Setae 7-17 mm. long, orange-brown; capsules 1-1.5 mm. long, suberect to strongly inclined, asymmetric, oblong-cylindric, smooth, brown; annulus of about 2 rows of small cells; operculum obliquely rostrate, the beak often nearly as long as the urn; peristome teeth yellowish to brownish; endostome segments not perforate, cilia 1-2, long and delicate. Spores 13-18 $\mu$, very faintly roughened.–n = 6, 7.

Darlington, Mosses of Michigan, fig. 131. Grout, Moss Flora of North America 3: Pl. 35A. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 47 & (ed. 2) Pl. 51 (as *Stereodon*). Welch, Mosses of Indiana, fig. 197.–**Fig. 885-889.**

On soil, humus, and bases of trees in moist woods. From Nova Scotia through the Great Lakes and south to North Carolina and Iowa; reported from Japan.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Burt Lake, Bryants Bog, Ingleside, Livingston Bog, Grass Bay, Mud Lake. EMMET CO.–Galloway Bog, Arnott Lake, Carp Lake, Pleasantview Swamp, Stutsmanville, Good Hart, Five Mile Creek, Wycamp Lake, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, Cut River, Epoufette, Hendricks, McNamara Pond, St. Martins Point, McKays Creek, Prentiss Bay. PRESQUE ISLE CO.–Clinton Lake, Kelsey Pond.

Recognizable because of an extraordinary golden sheen. Only *Plagiothecium laetum,* among local mosses, is so shiny. *Brotherella* is easily distinguished because of soft, crowded, complanate leaves with secund tips. The few abruptly inflated cells at the extreme angles are distinctive among our local *Hypnum*-like mosses, but they are only a poor imitation of the beautiful "bubble cells" of *Sematophyllum.* The latter




*Brotherella recurvans.* 885. Habit. 886. Leaves. 887. Cells at leaf tip. 888. Alar cells. 889. Capsule.

*Sematophyllum demissum.* 890. Leaves. 891. Upper cells of leaf. 892. Alar cells.

genus, represented in a single locality in southern Michigan by **S. demissum** (Wils.) Mitt. (fig. 890-892), is also distinguished by collenchymatous exothecial cells and suberect, homomallous leaves.

**Brotherella tenuirostris** (Bruch & Schimp. *ex* Sull.) Fl. often resembles forms of *Hypnum pallescens.* As compared with *Brotherella recurvans,* the plants are rather smaller, only moderately shiny and often dark-green, with leaves secund and not at all complanate, 0.5-1 mm. long, moderately serrulate above; the capsules are erect and symmetric. Brown, papillose, filiform brood-bodies are often found in the leaf axils. The species has been found in several southern counties (Eaton, Ingham, and Van Buren).

## HYPNACEAE

Plants small to robust, in loose or dense, often shiny mats. Stems mostly creeping, sometimes ascending, irregularly branched to very regularly pinnate and sometimes frondose; paraphyllia generally lacking. Leaves of stems and branches mostly uniform, often homomallous to secund or falcate-secund, occasionally somewhat

complanate, rarely plicate, of various shapes, mostly ± long-acuminate; costa short and double or none; cells prosenchymatous (mostly linear), smooth or occasionally papillose at back because of projecting upper angles, very rarely with several papillae in a row over the lumen at back, mostly differentiated at the basal angles, small and quadrate or sometimes moderately enlarged and inflated in rather small but usually distinct alar groups. Perichaetia lateral; perichaetial leaves differentiated. Setae elongate, mostly smooth; capsules erect or more commonly inclined to horizontal, ovoid to cylindric, straight or curved and asymmetric; annulus usually differentiated; operculum conic or sometimes convex, often rostrate; peristome nearly always double, the 16 teeth lance-subulate, usually cross-striolate below, usually bordered and strongly trabeculate; endostome (rarely lacking) usually consisting of a high basal membrane, broad, keeled segments, and well-developed, nodose cilia (but the teeth may be papillose, basal membrane low, segments filiform, and cilia rudimentary or lacking). Spores spherical. Calyptrae cucullate, smooth, naked or rarely ± hairy.

1. Stem and branch leaves differentiated; stem leaves broadly decurrent; leaf cells papillose at back because of projecting ends — 9. *Ctenidium*
1. Stem and branch leaves not particularly differentiated, not or somewhat decurrent; cells not papillose
 2. Plants rather large, handsome, pinnately branched to form triangular fronds; leaves strongly plicate — 10. *Ptilium*
 2. Plants small to medium-sized, not particularly striking in appearance, variously branched but not frondose; leaves smooth or only obscurely plicate
  3. Very small plants; leaves 0.1-0.5 mm. long — 4. *Platydictya*
  3. Plants small to fairly robust; leaves more than 0.5 mm. long
   4. Capsules erect and symmetric
    5. Plants dark-green with a golden, oily sheen; branches ± straight; leaves erect when dry; clusters of brood branchlets in leaf axils; margins reflexed; dioicous; basal membrane of endostome low; cilia none — 1. *Platygyrium*
    5. Plants light-green or yellowish, moderately shiny; branches curved when dry; leaves appressed and somewhat homomallous when dry; margins erect; brood branchlets lacking; autoicous; basal membrane well developed; cilia rudimentary — 2. *Pylaisiella*
   4. Capsules variously inclined, curved, and asymmetric
    6. Leaves 0.5-0.8 mm. long, erect or appressed, not at all complanate or secund — 3. *Homomallium*
    6. Leaves longer, mostly ± complanate or secund
     7. Leaves secund or falcate-secund; alar cells differentiated, small and quadrate or larger and ± inflated — 7. *Hypnum*
     7. Leaves mostly ± complanate, not or somewhat secund at the tips; alar cells scarcely differentiated
      8. Leaves strongly complanate; apical cells shorter than the median — 6. *Taxiphyllum*
      8. Leaves not or loosely complanate; apical cells not differentiated
       9. Leaves 0.7-1.2 mm. long, entire; capsules oblong-cylindric, smooth — 5. *Isopterygium*
       9. Leaves 1.2-1.5 mm. long, serrulate; capsules curved-cylindric, plicate — 8. *Herzogiella*

## 1. **Platygyrium** BSG, *nom. cons.*

Rather small plants in flat, dark-, yellowish-, golden-, or brownish-green, glossy mats. Stems creeping, freely branched; branches ascending, often somewhat curved, short, usually bearing clusters of minute brood-branches in axils of upper leaves. Stem and branch leaves similar, erect or appressed when dry, erect-spreading when moist, concave, ovate- or oblong-lanceolate, acuminate, slightly decurrent; margins entire or nearly so, reflexed in the lower 1/2-2/3; costa short and double or lacking; cells smooth, rhomboidal, shorter at the apex, quadrate in several rows in well-marked, triangular alar groups. Dioicous; perichaetial leaves somewhat elongate, with ± spreading tips. Setae reddish, smooth; capsules erect and symmetric, cylindric; annulus of 2-4 rows of cells, persistent; operculum obliquely conic-rostrate; stomata few, at extreme base of the urn; peristome teeth inserted near the mouth, lanceolate, yellow-brown,

transversely striolate-papillose at base, papillose above; endostome yellowish, smooth, about 2/3 as long as the teeth, consisting of a very low basal membrane, nearly linear, non-perforate segments, and no cilia. Calyptrae naked.–Named in reference to the broad annulus.

**Platygyrium repens** (Brid.) BSG–Leaves 0.8-1.3 mm. long; upper median cells about 6-10:1. Setae 10-25 mm. long; capsules 1.5-2.2 mm. long. Spores 11-15 $\mu$, finely papillose.

Breen, Mosses of Florida, Pl. 88 (figs. 7-10). Conard, How to Know the Mosses, (ed. 2) fig. 261. Darlington, Mosses of Michigan, fig. 137. Grout, Mosses with Hand-lens and Microscope, fig. 208. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 33, (ed. 2) Pl. 37. Welch, Mosses of Indiana, fig. 206.–**Fig. 893-897.**

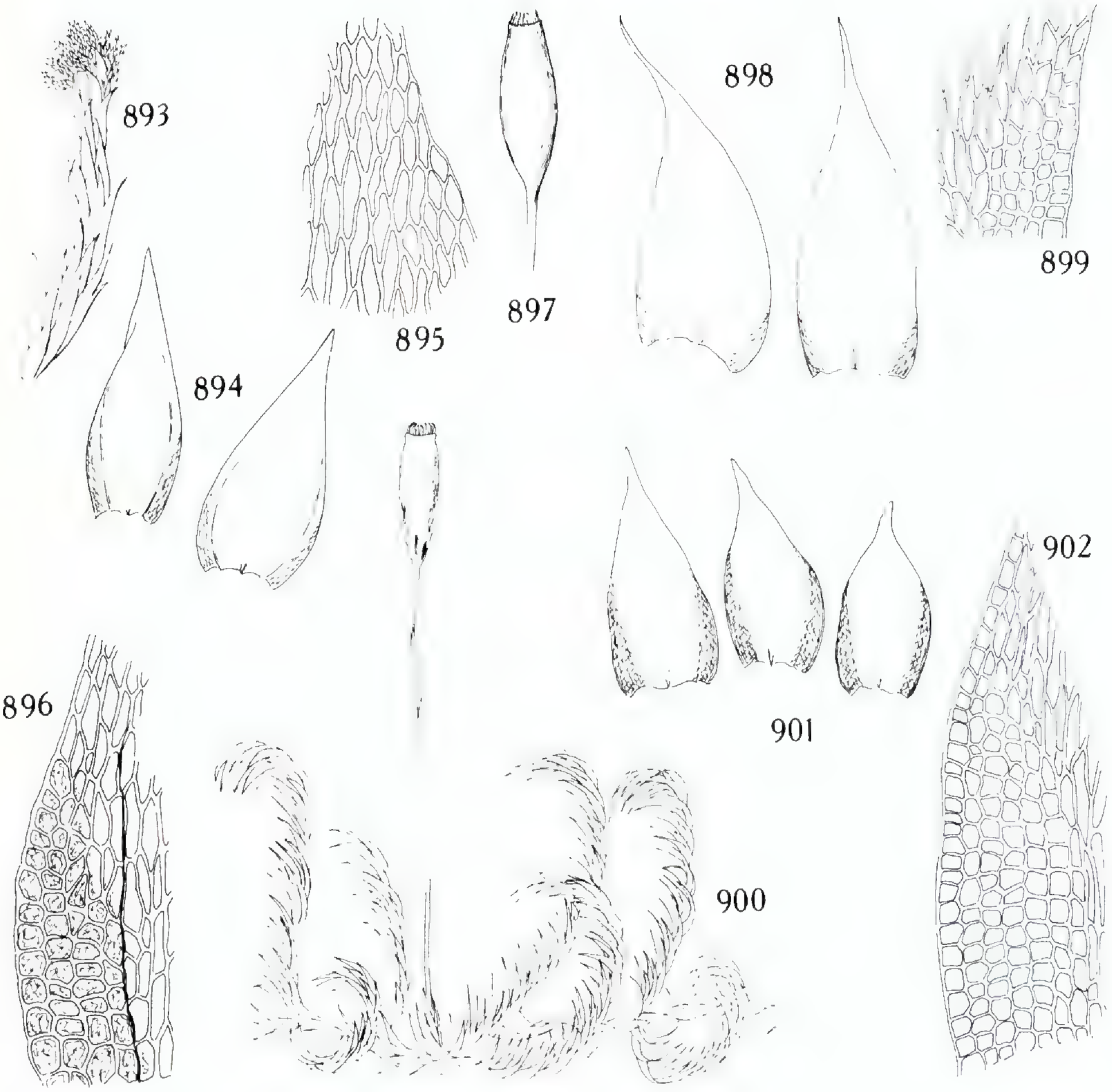
On logs and stumps, bark of trees, and occasionally on rocks, often in rather dry, brushy, disturbed places, such as roadsides, pastures, and edges of woodlots. Circumpolar; British Columbia to New Brunswick, throughout eastern North America.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Pine Point, Livingston Bog, Grass Bay, Weber Lake. EMMET CO.–Pellston Dunes, Maple River, Pleasantview Swamp, Arnott Lake, Cross Village, Good Hart, Middle Village, Wilderness State Park, Alanson, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Gros Cap, Cut River, Epoufette, Ozark, Hendricks. PRESQUE ISLE CO.–Evergreen Beach, Lamprey Experiment Station, Mast Point, Rainy River Falls.

*Platygyrium repens* is common on trunks of trees, especially in open places in woods or in brushy ecotones, as blackish-green mats with a curious oily sheen. The axillary clusters of brood-branchlets (actually little buds) are invariably present and provide the easiest means of recognition. *Leskeella nervosa* has similar branchlets, but the plants are a dull dark-green, the leaves are narrower and long-pointed, and the costa is single and nearly fills the leaf apex. *Homomallium adnatum,* which grows on rock and also on bark at base of trees, is distinguished from *Platygyrium* by erect leaf margins.

## 2. **Pylaisiella** Kindb.

Plants rather slender or medium-sized, in flat, yellowish, light- to dark-green, or brownish, ± shiny mats. Stems creeping, irregularly or subpinnately branched; branches short, erect-ascending, usually curved. Stem and branch leaves similar, crowded, usually homomallous, loosely appressed when dry, erect-spreading when moist, concave, ovate- or oblong-lanceolate, short- to long-acuminate; margins mostly erect and entire; cells linear or linear-rhomboidal, small and quadrate in several rows at the basal angles. Autoicous; perichaetial leaves oblong- or ovate-lanceolate, ± long-acuminate, serrulate at the apex. Setae smooth; capsules erect and symmetric (or rarely somewhat curved), ovoid- or oblong-cylindric; annulus present or lacking; operculum conic, sometimes ± rostrate; peristome deeply inserted, the teeth cross-striolate (or sometimes smooth or indistinctly striolate), bordered, trabeculate; endostome free or ± adherent to the teeth, the basal membrane well developed, segments lance-subulate, keeled and variously perforate or split, cilia mostly rudimentary. Calyptrae naked.–A diminutive of *Pylaisia,* the name given the genus in honor of an early French bryologist, Bachelot de la Pylaie. Unfortunately the name had already been used and is not available for use in bryology. The genus is readily recognized by crowded, short, slender branches curved upward when dry (somewhat resembling a small and soft *Leucodon*). *Platygyrium* is not sharply distinct from *Pylaisiella* but differs in habit and dioicous inflorescence, better-developed annulus, endostome with a very low basal membrane (not exserted above the mouth), narrower segments, and cilia completely lacking.




*Platygyrium repens.* 893. Branch and brood-branchlets. 894. Leaves. 895. Cells at margin of leaf near apex. 896. Cells at basal angle of leaf. 897. Capsule.
*Pylaisiella polyantha.* 898. Leaves. 899. Alar cells.
*Pylaisiella selwynii.* 900. Habit. 901. Leaves. 902. Alar cells.

Quadrate alar cells relatively few (only 3-9 along the margins); endostome free 1. *P. polyantha*
Quadrate alar cells many (about 15-20 along the margins); endostome partially adherent to the teeth 2. *P. selwynii*

1. **Pylaisiella polyantha** (Hedw.) Grout–Plants in glossy, green or yellowish mats. Leaves 1-1.3 mm. long, ovate or ovate-lanceolate, gradually or rather abruptly long-acuminate, entire or slightly serrulate above; quadrate alar cells relatively few (3-9 at the margins). Setae 6-10 mm. long; capsules 1.3-2 mm. long, oblong-cylindric; annulus narrow; operculum conic or conic-apiculate; segments of endostome free. Spores 9-15 $\mu$ finely papillose.–n = 11.

Conard, How to Know the Mosses, (ed. 2) fig. 288a-e (as *Pylaisia*). Darlington, Mosses of Michigan, fig. 136 (as *Pylaisia*). Grout, Moss Flora of North America 3: Pl. 35G (as *Pylaisia*).–**Fig. 898-899.**

On bark of trees. Circumpolar; across Canada and Alaska, presumably south to Arizona in the West and the Gulf of Mexico in the East.

CHEBOYGAN CO.–Reeses Bog, Gorge of Carp Creek, Iron Bridge, Mullet Lake. EMMET CO.–Wycamp Creek, Mackinaw City Hardwoods, Cecil Bay, Big Stone Bay. MACKINAC CO.–Bois Blanc Island, Mackinac Island. PRESQUE ISLE CO.–Presque Isle Lighthouse, Hammond Bay.

The plants are looser and the branches less tightly curled than in *P. selwynii.* The segments of the endostome are completely free from the exostome, and so both parts of the peristome can be seen with a hand-lens; in our other species, *P. selwynii,* the endostome is at least partly adherent to the exostome and cannot be detected in a dry condition under low magnifications.

2. **Pylaisiella selwynii** (Kindb.) Crum, Steere & Anders.–Plants in rather glossy, green or yellow-green mats. Branch leaves crowded, 0.5-1.3 mm. long, ovate-lanceolate and acuminate, entire or nearly so; alar cells numerous (15-20 at the margins and extending about 1/3 up the leaf). Setae 6-14 mm. long; capsules 1-2 mm. long, oblong-cylindric; annulus of 2-3 rows of cells; operculum conic, obliquely blunt-tipped; segments of endostome adhering to the teeth in the lower 2/3. Spores 13-24 $\mu$, densely papillose.–n = 10+1, 11.

Conard, How to Know the Mosses, (ed. 2) fig. 287 (as *Pylaisia*). Grout, Mosses with Hand-lens and Microscope, Pl. 85 (as *Pylaisia schimperi*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 33 (as *Pylaisia schimperi*), (ed. 2) Pl. 37 (as *Pylaisia*). Welch, Mosses of Indiana, fig. 204 (as *Pylaisia*).–**Fig. 900-902.**

On bark of trees. Apparently rare in northern Europe, Siberia, and Japan; southern Canada to the Gulf of Mexico; reported from Arizona; Sonora.

CHEBOYGAN CO.–Reeses Bog, Gorge of Carp Creek, Douglas Lake, Smiths Bog, Colonial Point, Mill Creek. EMMET CO.–Larks Lake, Cross Village, Wilderness State Park. MACKINAC CO.–Mackinac Island, Gros Cap, Ozark, Caffey Corner, Hendricks. PRESQUE ISLE CO.–Evergreen Beach, Clinton Lake.

The neatly curved branches are smaller and more compact than those of *P. polyantha.*

**Pylaisiella intricata** (Hedw.) Grout, widespread in the Northeast but not known to occur in Michigan, has segments wholly adherent to the teeth, alar cells less than 10 at the margins, and spores 20-30 $\mu$.

### 3. **Homomallium** (Schimp.) Loeske

Plants small to medium-sized, in flat, dark- or brownish-green to yellowish, dull or ± shiny mats. Stems creeping, freely and irregularly to subpinnately branched; branches short, straight or somewhat curved; paraphyllia few. Stem and branch leaves similar, erect to erect-spreading or homomallous, concave, oblong-lanceolate or oblong-ovate, acuminate; margins erect, entire or ± serrulate near the apex; upper cells rhomboidal, smooth or papillose at back because of projecting cell ends; alar cells quadrate in numerous rows. Autoicous; perichaetial leaves elongate, loosely sheathing. Setae smooth; capsules inclined to horizontal, curved and constricted below the mouth when dry and empty; annulus differentiated; operculum convex-conic, blunt to apiculate or rostellate; peristome teeth cross-striolate below, papillose above, bordered and trabeculate; endostome papillose, with a high basal membrane, keeled and sometimes perforate segments, and well-developed, nodulose cilia in groups of 1-3. Calyptrae naked.–Named in reference to a tuft (or woolly mat) in which the leaves are curved or directed in the same way (characteristic of some of the species).

**Homomallium adnatum** (Hedw.) Broth.–Small plants in dull, dark-green or blackish to brownish mats. Stems freely but irregularly branched; branches short and straight. Leaves erect (or very slightly secund) when dry, erect-spreading when moist, 0.5-0.8 mm. long, oblong-ovate, rather abruptly short-acuminate; margins entire or nearly so; upper cells smooth, thick-walled, shortly oblong-rhomboidal, about 5-6:1; alar cells quadrate in triangular groups extending about 1/3 up the leaf. Setae 6-12 mm. long, orange-yellow; capsules 1-1.5 mm. long, yellowish; operculum obliquely and stoutly apiculate or rostellate; stomata at extreme base of the urn; segments not perforate; cilia in groups of 1-2. Spores 11-12 $\mu$, smooth or very finely papillose.

Conard, How to Know the Mosses, (ed. 2) fig. 259. Darlington, Mosses of Michigan, fig. 134. Grout, Mosses with Hand-lens and Microscope, figs. 202(5) & 203 (as *Amblystegiella*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 39, (ed. 2) Pl. 43.–**Fig. 903-905.**

On rocks (especially limestone), rarely on bases of hardwood trees. Eastern North America; Japan.

CHEBOYGAN CO.–Pine Point (Douglas Lake).

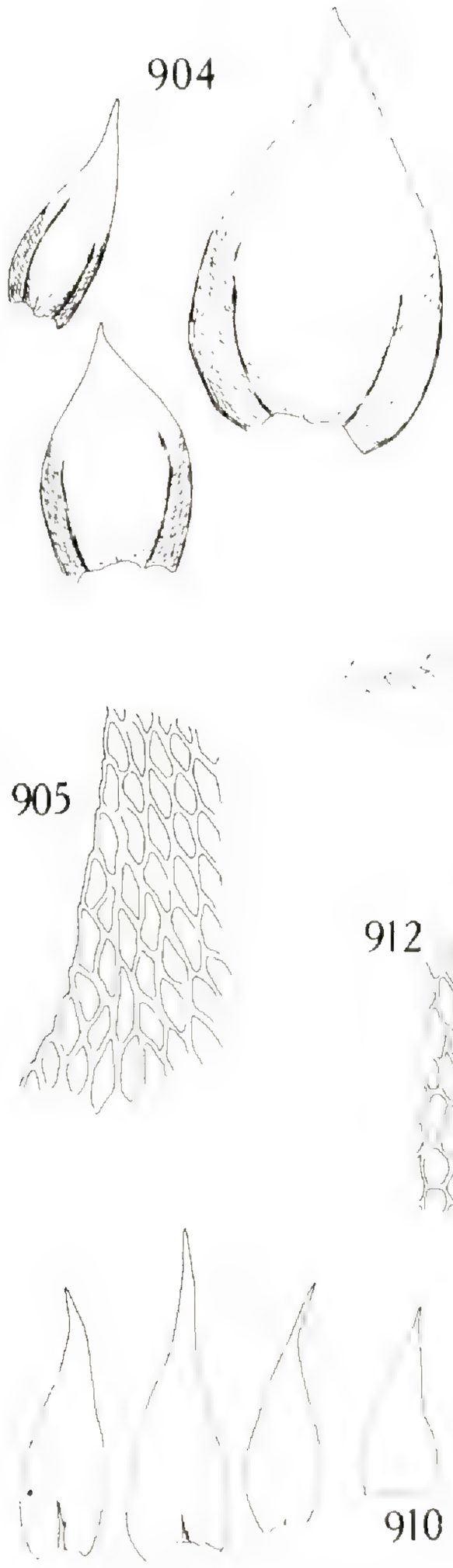
Rather similar to *Platygyrium repens* in appearance but differs most noticeably in having leaves with erect, rather than reflexed margins. The habitats, of course, are normally quite different.

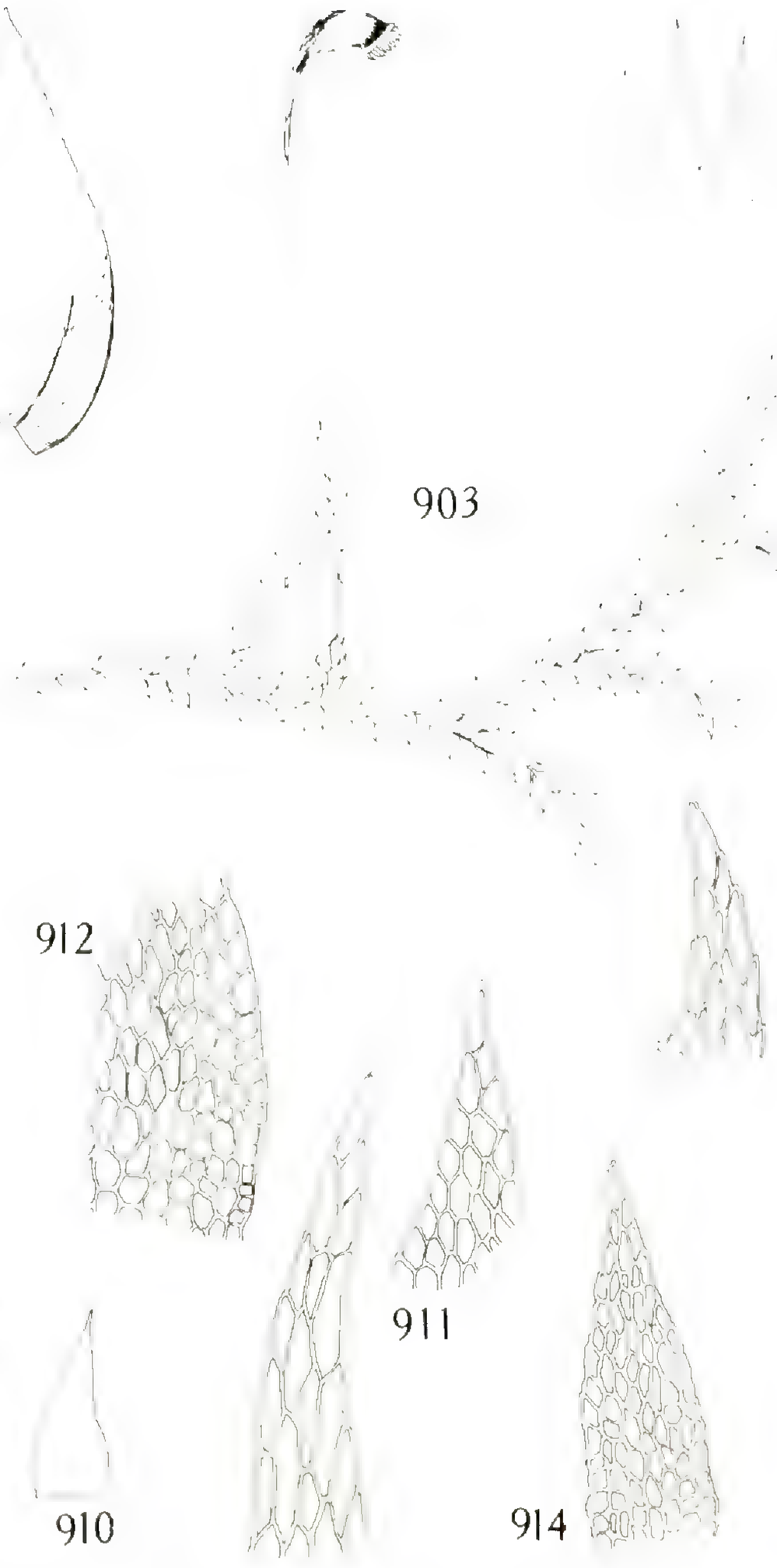
## 4. **Platydictya** Berk.

Plants small and slender, in dark-, light-green or brownish, dull or slightly shiny mats. Stems mostly creeping, irregularly branched; paraphyllia none. Leaves very small, slightly concave, erect-spreading or weakly secund when moist, lanceolate or lance-subulate, not or shortly and indistinctly decurrent; margins plane and entire or serrulate; cells rhomboidal or oblong-hexagonal, mostly short (2-4, rarely 8 times as long as broad), shorter and somewhat laxer at base, subquadrate and poorly differentiated at the basal angles. Perichaetial leaves erect, sheathing at base, oblong-lanceolate, long-acuminate. Setae slender, reddish, smooth; capsules mostly erect and symmetric or weakly curved (sometimes inclined and more distinctly curved), oblong-cylindric, mostly constricted below the mouth when dry and empty, smooth; annulus differentiated; operculum convex, blunt or obliquely apiculate; peristome teeth cross-striolate below, bordered, ± trabeculate; basal membrane of endostome low to moderately high, segments well developed, cilia single and rudimentary to lacking or rarely in 2's and 3's and well developed.–The name apparently refers to a broad-meshed network formed by the outlines of the short leaf cells and is not obviously appropriate. (The genus has been called *Amblystegiella,* because of some resemblance to *Amblystegium,* but that name is nomenclaturally unavailable.)

1. Silky, green or yellowish, soft plants with serrulate leaves; alar cells scarcely differentiated; perichaetial leaves spinulose-denticulate — 1. *P. jungermannioides*
1. Dull, dark-green, ± rigid plants with subentire leaves; quadrate alar cells more numerous; perichaetial leaves entire or slightly denticulate
  2. On bark at base of trees; leaves 0.25-0.5 mm. long; cells 3-5:1; capsules erect and symmetric or nearly so; operculum conic, obliquely pointed — 2. *P. subtile*
  2. On limestone rocks; leaves 0.15-0.3 mm. long;.cells 2-3:1. capsules curved and strongly inclined; operculum convex-conic, not obliquely pointed — 3. *P. confervoides*

1. **Platydictya jungermannioides** (Brid.) Crum–Soft, silky, green or yellowish plants with creeping stems and ascending branches. Short-cylindric or clavate brood-bodies sometimes produced in leaf axils. Leaves erect-spreading, 0.17-0.3, rarely



*Homomallium adnatum.* 903. Habit. 904. Leaves. 905. Cells of upper part of leaf.
*Platydictya jungermannioides.* 906. Habit. 907. Leaves. 908. Cells at apex of two leaves. 909. Cells at leaf base.
*Platydictya subtile.* 910. Leaves. 911. Cells at tip of two leaves. 912. Alar cells.
*Platydictya confervoides.* 913. Leaves. 914. Areolation of entire leaf.

0.5 mm. long, lanceolate, acuminate, not or somewhat narrowed to the insertion; margins serrulate throughout (but especially at the base); cells elongate throughout, oblong-rhomboidal and about 3-4:1 above, a few at the basal angles subquadrate (usually no more than 3, sometimes as many as 7 at the margins). Dioicous; perichaetial leaves denticulate. Setae 6-11 mm. long; capsules erect and symmetric or nearly so, contracted below the mouth when dry, 0.6-1 mm. long; operculum convex-conic and mammillate to rostellate; cilia of endostome none or 1-2. Spores 11-13 $\mu$, finely papillose.

Grout, Mosses with Hand-lens and Microscope, fig. 202(2), as *Amblystegiella sprucei.*–**Fig. 906-909.**

In damp, shaded places, especially in crevices of cliffs, also found in sheltered habitats on logs, bases of trees, and soil of banks or roots of upturned trees. Circumpolar; Canada and Alaska, south to New Mexico, the Great Lakes, and New England.

CHEBOYGAN CO.–Reeses Bog, Colonial Point, Grass Bay. EMMET CO.–Arnott Lake, Cecil Bay, Wilderness State Park. MACKINAC CO.–Mackinac Island, McKays Creek.

Extremely small, delicate, pale-green plants resembling a minute *Amblystegium* but lacking a costa; this species is most likely to be confused with *Isopterygium pulchellum,* which is larger, very glossy, and has entire leaves which are in two apparent rows but more or less curved and homomallous.

2. **Platydictya subtile** (Hedw.) Crum–Rather dull, green to brownish plants with creeping stems and erect branches. Leaves erect-spreading or subsecund, 0.25-0.5 mm. long, lanceolate, acuminate, ± narrowed to the insertion, entire or nearly so; upper cells oblong-rhomboidal, about 3-5:1; subquadrate alar cells rather numerous (about 7-16 along the margins). Autoicous; perichaetial leaves entire or nearly so. Setae 7-12 mm. long; capsules erect and symmetric or slightly inclined, oblong-cylindric, not or slightly contracted below the mouth when dry, about 1-1.5 mm. long; operculum conic, obliquely apiculate to rostellate; cilia of endostome none or rudimentary. Spores 9-13 $\mu$, finely papillose.–n = 10.

Conard, How to Know the Mosses, (ed. 2) fig. 260a-d (as *Amblystegiella*). Grout, Mosses with Hand-lens and Microscope, figs. 201, 202(3), as *Amblystegiella.*–**Fig. 910-912.**

On bark at base of hardwood trees. Europe; Asia; southeastern Canada to Minnesota, south to Pennsylvania and Illinois.

CHEBOYGAN CO.–Gorge of Carp Creek, Fairy Island, Colonial Point, Mud Lake, Mill Creek. EMMET CO.–Larks Lake, Pellston Hills, Big Stone Bay. MACKINAC CO.–Mackinac Island, Prentiss Bay, Gros Cap, Ozark, Hendricks.

Though small, the largest of the genus. The habit of growth at the base of hardwood trees is the easiest character to use in recognition.

3. **Platydictya confervoides** (Brid.) Crum–Dark-green, rather rigid plants with creeping stems and erect-ascending branches. Leaves erect or rarely subsecund when dry, erect-spreading when moist, 0.2-0.3 mm. long, lanceolate or ovate-lanceolate, acute, not or somewhat narrowed to the insertion, entire or nearly so; upper cells short, 2 (rarely 4):1, irregularly oblong-rhombic; basal cells short, those at the basal angles inconspicuously small and subquadrate (3-6, sometimes 12 along the margins). Autoicous; perichaetial leaves subentire. Setae 6-8 mm. long; capsules 0.8-1.2 mm. long, suberect to nearly horizontal; operculum convex-conic, apiculate; cilia of endostome 1-3, rather well developed. Spores 11-13 $\mu$, finely papillose.–n = 10.

Conard, How to Know the Mosses, (ed. 2) fig. 260e-f (as *Amblystegiella*). Darlington, Mosses of Michigan, fig. 135 (as *Amblystegiella*). Grout, Mosses with Hand-lens and Microscope, fig. 202(1), as *Amblystegiella.* Welch, Mosses of Indiana, fig. 202 (as *Amblystegiella*).–**Fig. 913-914.**

On limestone rocks in moist, shady places, especially in stream valleys. Europe and the Caucasus; southeastern Canada and northeastern United States (and presumably in the Rocky Mountains).

CHEBOYGAN CO.–Mill Creek. MACKINAC CO.–Mackinac Island, Ozark.

Very small, dark-green plants characteristically found in the valleys of streams on moist, shaded, calcareous rocks. The subquadrate alar cells are helpful in determination.

## 5. **Isopterygium** Mitt.

Small or medium-sized plants in soft, light- or yellowish-green, sometimes whitish mats, often somewhat glossy. Stems creeping or sometimes ascending, mostly irregularly branched. Stem and branch leaves similar, oblong- or ovate-lanceolate, acuminate, not or only slightly decurrent, the dorsal and ventral leaves obliquely appressed and symmetric, the lateral leaves usually spreading, ± complanate, sometimes ± asymmetric and frequently somewhat secund; margins plane, entire or serrulate; cells smooth (or rarely papillose at back because of projecting angles), narrow and elongate (mostly linear) above, shorter and thicker-walled or sometimes lax at the insertion, not or slightly differentiated at the basal angles. Perichaetial leaves erect, sheathing at base, gradually or abruptly subulate. Setae smooth; capsules small, suberect to strongly inclined, ± asymmetric, oblong-ovoid to subcylindric from a short, distinct neck; annulus sometimes differentiated; operculum conic or convex-conic, sometimes rostrate; peristome teeth cross-striolate, bordered, trabeculate; basal membrane of endostome high, segments keeled and sometimes perforate, cilia 1-3, delicate, sometimes nodose or ± appendiculate. Calyptrae naked.—The name means equal wings or sides and probably refers to the fact that the lateral leaves are often somewhat spreading and complanate, thus forming indistinct rows.

**Isopterygium pulchellum** (Hedw.) Jaeg. & Sauerb.—Plants small and slender, in shiny, bright-green or yellow mats. Stems creeping, irregularly branched; branches often ascending. Leaves usually not crowded, erect- to wide-spreading and somewhat to distinctly complanate, often ± secund at the tips, 0.7-1.2 mm. long, narrowly lanceolate, slenderly acuminate, entire; cells linear-flexuose, scarcely differentiated at the basal angles. Autoicous. Setae 8-16 mm. long, orange or yellow, becoming orange-red; capsules suberect and nearly symmetric to inclined and ± asymmetric, oblong-cylindric, smooth, 1-1.6 mm. long; annulus of 2 rows of cells; operculum bluntly low-conic; stomata at extreme base of the urn; endostome segments non-perforate, the cilia single (or occasionally paired), nodulose. Spores 9-13 $\mu$, minutely roughened.—n = 10, 11, 22.

Darlington, Mosses of Michigan, fig. 130.—**Fig. 915-917.**

On damp soil, humus, rock, or bark at base of trees in deep shade, often under overhanging turf, in crevices, or on undersides of logs. Circumpolar; New Zealand; Greenland to Alaska, south to California, Arizona, Colorado, Wisconsin, and New York.

CHEBOYGAN CO.—Hermits Bog. EMMET CO.—Arnott Lake, Pleasantview Swamp. PRESQUE ISLE CO.—Rainy Lake.

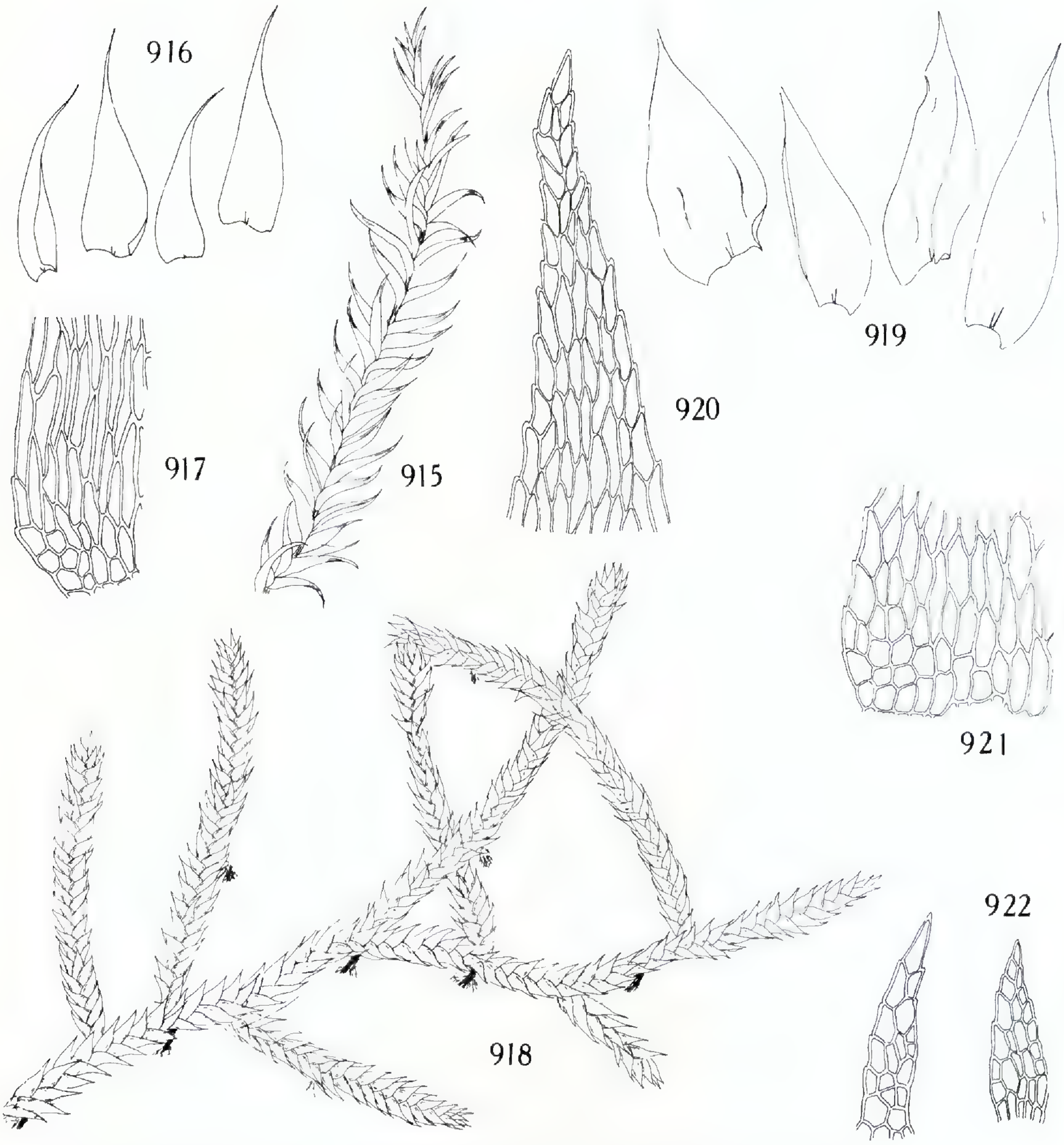
Indeed pretty and small, as the name indicates, the plants are usually interlaced with other mosses in moist, protected niches. The branches are erect or ascending, and the leaves, shiny when dry, are flattened into two apparent rows and also somewhat curved and homomallous.

**Isopterygium distichaceum** (Mitt.) Jaeg. & Sauerb. has been found at the Lower Falls of the Tahquamenon River in nearby Chippewa County (and also in Alger Co.). It is larger, with glossy leaves wide-spreading and complanate, often somewhat undulate, and commonly subsecund at the tips. Its outstanding features are the asymmetric leaves and small, slender brood branches in terminal clumps. (In I. elegans (Brid.) Lindb., the brood branches are distributed throughout the length of the stems and branches.)

**Isopterygiopsis muelleriana** (Schimp.) Iwats., a rare species on non-calcareous rock in the Upper Peninsula (Ontonagon Co.), differs from *Isopterygium* in its rigidly distichous-complanate leaves, usually crowded and pectinate in arrangement, and large, hyaline, relatively thin-walled cortical cells. Somewhat similar forms of *Isopterygium pulchellum* with rigidly complanate leaves have thick-walled cortical cells and narrower leaves.

## 6. **Taxiphyllum** Fl.

Plants small to medium-sized, in flat, green or yellow, often glossy mats. Stems prostrate, sparsely to irregularly or subpinnately branched; pseudoparaphyllia generally present and lanceolate. Stem and branch leaves similar, often crowded, spreading and complanate in 2 apparent rows, oblong-ovate or oblong-lanceolate and short- to




*Isopterygium pulchellum*. 915. Habit. 916. Leaves. 917. Cells of alar region.
*Taxiphyllum deplanatum*. 918. Habit. 919. Leaves. 920. Cells at leaf tip. 921. Cells at basal margin of leaf. 922. Paraphyllia.

long-acuminate (or rarely oblong-lingulate and blunt), mostly concave, not or somewhat asymmetric; margins plane or sometimes narrowly recurved, at least below, serrulate nearly all around; cells linear-flexuose, sometimes thickened and ± punctate at the ends and thus appearing papillose, shorter at the apex and at the insertion, subquadrate in small alar groups. Dioicous; perichaetial leaves erect at base, with slender, somewhat spreading acumina. Setae smooth; capsules erect or inclined, oblong-ovoid with a distinct neck; annulus persistent, of 2 rows of cells; operculum obliquely rostrate; peristome teeth cross-striolate below, papillose above, bordered, trabeculate; endostome hyaline, papillose, with a high basal membrane, keeled segments, and cilia in groups of 2 or 3 (rarely single). Calyptrae naked.–The name refers to the apparent arrangement of leaves in two rows.

**Taxiphyllum deplanatum** (Bruch & Schimp. *ex* Sull.) Fl.–Plants in loose or dense, light-green or yellow, shiny mats. Pseudoparaphyllia lanceolate. Leaves crowded and overlapping, spreading and strongly complanate, not plicate, 1.5-2 mm. long, ovate-lanceolate or occasionally oblong-lanceolate, slenderly acuminate, narrowly acute; margins plane, or narrowly recurved near the base, serrulate nearly all around (more strongly so near the apex). Setae 6-16 mm. long; capsules 1.3-2 mm. long, erect or somewhat inclined, not or only somewhat asymmetric, constricted below the mouth and at the neck when dry; stomata in the neck; exostome teeth very pale and brownish or yellowish; endostome with non-perforate segments and cilia in 2's. Spores about 11-13 $\mu$, nearly smooth.

Conard, How to Know the Mosses, (ed. 2) fig. 297 (as *Plagiothecium*). Grout, Mosses with Hand-lens and Microscope, fig. 199 (as *Plagiothecium*), Moss Flora of North America 3: Pl. 42B (as *Plagiothecium*). Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 69 (as *Isopterygium*). Welch, Mosses of Indiana, fig. 210 (as *Plagiothecium*).–**Fig. 918-922.**

On calcareous rock or soil. Widespread in eastern North America, from Saskatchewan to Quebec, south to North Carolina and Louisiana; Arizona and New Mexico.

CHEBOYGAN CO.–Douglas Lake. MACKINAC CO.–Mackinac Island, Caffey Corner.

Recognized by the crowded and overlapping, spreading and complanate leaves with narrow points. A related species, not found in the state, is **T. taxirameum** (Mitt.) Fl., known in most books as *T. geophilum* (Aust.) Fl.; it has leaves relatively distant and more broadly pointed.

## 7. **Hypnum** Hedw.

Plants slender to fairly robust, in soft, green, yellowish, brownish-, or golden-green mats or tufts. Stems mostly creeping, irregularly to pinnately branched; stems and branches usually hooked at the tips; paraphyllia none or few. Stem and branch leaves similar, crowded, secund or falcate-secund, often in 2 apparent rows, concave, symmetric, ovate- or oblong-lanceolate, acuminate, not or somewhat decurrent; margins erect or reflexed below, rarely revolute, entire or serrulate above; cells smooth, linear or rhomboidal, mostly incrassate and porose at the insertion, usually clearly differentiated at the basal angles (small and quadrate or laxly oblong, inflated, pale and thin-walled to thick-walled and colored). Perichaetial leaves slenderly long-acuminate, generally ± striate. Setae smooth; capsules inclined to horizontal (or rarely suberect), usually ± curved and asymmetric, oblong-cylindric; annulus usually present; operculum conic or convex-conic, mammillate to apiculate or ± rostrate; stomata at base of the capsule; peristome teeth cross-striolate and bordered below, papillose above, trabeculate at back; endostome with a well-developed basal membrane, not or narrowly perforate,

keeled segments, and cilia in 2's and 3's (rarely single). Calyptrae naked.—The generic name, derived from a Greek word for sleep (as is the word hypnosis), was applied in antiquity to some epiphytic mosses or lichens used as medicinal ingredients. Dillenius, in 1741, used the name for pleurocarps of the sort sometimes called FEATHER MOSSES. Such mosses would seem suitable for stuffing pillows and thus inducing sleep, but Dillenius tried, in the spirit of scholasticism, to justify ancient usage by imagining a soporific fragrance emanating from them. The genus has continued until recent times to be used in an inclusive sense, meaning most of the pleurocarps, and with good justification as most of them have the "perfect double" peristome (also known as the "hypnaceous" peristome described above), giving obvious evidence of common origin. In the interest of practicality, the genus has been subdivided into many genera in several families. These families, based mainly on gametophytic characters, show virtual uniformity in sporophytic features, especially in details of peristome structure. For those who question the value of families so poorly differentiated and so difficult to define, I would point out that in Lesquereux and James' *Manual of the Mosses of North America,* of 1884, there are 195 species of *Hypnum*—making a truly pesky and unmanageable genus! Even in Dixon's admirable *Students Handbook of British Mosses,* last revised in 1924 and still used as a standard reference, the genus embraced at least 15 genera in common usage today, 11 of them distributed in three families in this work. (It is interesting to note that in his many publications Dixon exhibited Dr. Jekyll-Mr. Hyde characteristics in lumping genera shamelessly at home but splitting them with equal abandon abroad!)

1. Alar cells small, quadrate, not thin-walled or inflated; capsules suberect
  2. Rather robust plants with opaque, quadrate alar cells in rather conspicuous groups (about 4-6 along the leaf margins, below them a few somewhat larger, hyaline or orange-brown cells) 5. *H. imponens*
  2. Rather small plants with numerous opaque, quadrate alar cells in triangular groups
    3. Dioicous; leaves crowded and appressed, giving stems and branches a terete appearance; leaf margins erect, entire or serrulate above; alar cells many 3. *H. cupressiforme*
    3. Autoicous; leaves less crowded, not appressed; leaf margins usually reflexed below, serrulate nearly all around, sharply so above; alar cells rather numerous 4. *H. pallescens*
1. Alar cells hyaline, ± enlarged or inflated, thin-walled; capsules inclined
  4. Stems prostrate, closely and regularly pinnate; cortical cells not or somewhat enlarged; leaves serrulate to well below the apex, usually in the upper 1/3-1/2
    5. Cortical cells not enlarged; pseudoparaphyllia none; leaves broad, triangular-ovate, rather broadly acuminate, abruptly rounded above a few inflated alar cells; dioicous 6. *H. curvifolium*
    5. Cortical cells somewhat enlarged; pseudoparaphyllia at branch insertions; leaves narrow, oblong-lanceolate, slenderly long-acuminate, somewhat rounded to the insertion; autoicous 7. *H. fertile*
  4. Stems usually ascending, loosely and irregularly branched; cortical cells conspicuously enlarged; leaves entire or serrulate only near the apex
    6. Leaves somewhat complanate, usually strongly concave and conspicuously falcate-secund, often ± furrowed when dry, not or slightly rounded to the insertion; alar cells abruptly inflated in large decurrencies delimited above by small cells 1. *H. lindbergii*
    6. Leaves loosely complanate, moderately concave, curved-secund at the tips, not longitudinally furrowed but often ± wrinkled transversely when dry, rounded to the insertion; alar cells enlarged but not particularly inflated, in gradually differentiated groups 2. *H. pratense*

1. **Hypnum lindbergii** Mitt.—Fairly robust plants in loose, light-green to yellowish or brownish, shiny mats. Stems ascending, irregularly or subpinnately branched; cortical cells of stems and branches large and hyaline (stripping off with leaves on dissection and obviously broader than the leaf cells). Leaves erect-spreading and ± complanate with falcate-secund tips (especially so at tips of stems and branches), smooth or sometimes obscurely plicate when dry, concave, about 1-2.5 mm. long, oblong-ovate, gradually narrowed to a fairly broad or slender, acute acumen, decurrent;

margins plane, entire or sometimes serrulate at the apex; costa short and double; upper cells linear; basal cells shorter, broader, thick-walled and pitted, becoming yellowish; alar cells abruptly inflated, hyaline, and thin-walled, in large, decurrent groups delimited above by small, ± quadrate cells. Dioicous. Setae 25-37 mm. long; capsules inclined to horizontal, curved and asymmetric, 2-2.5 mm. long, ± furrowed when dry and empty; annulus large; operculum convex-conic and apiculate; cilia 2-4. Spores 13-22 $\mu$, very finely papillose.—n = 9+1, 10, 11.

Breen, Mosses of Florida, Pl. 84 (figs. 1-4). Conard, How to Know the Mosses, (ed. 2) fig. 276 (as *H. pratense*). Grout, Mosses with Hand-lens and Microscope, fig. 188 (as *H. patientiae*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 46 (as *Stereodon arcuatus*), (ed. 2) Pl. 50 (as *S. patientiae*). Welch, Mosses of Indiana, fig. 194 (as *H. arcuatum*).—**Fig. 923-924.**

On wet soil, humus, rotten wood, etc., in swampy places, particularly near lakes and ponds. Circumpolar; arctic North America to Washington, Colorado, and the Gulf of Mexico.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Burt Lake, North Fishtail Bay (Douglas Lake), Smiths Bog, Levering—Cheboygan road, Mill Creek, Grass Bay. EMMET CO.—Pleasantview Swamp, Levering, Larks Lake, Wycamp Lake, Cecil Bay, Big Stone Bay, Ramona Beach. MACKINAC CO.—Bois Blanc Island, Mackinac Island, McKays Creek, Cut River, Ozark. PRESQUE ISLE CO.—Evergreen Beach, Hammond Bay, Mast Point, Clinton Lake, Kelsey Pond, Rainy Lake.

*Hypnum lindbergii,* very common in swampy habitats, is pale, whitish-green, and glossy when fresh. The falcate leaves are irregularly plicate when dry, scarcely rounded to the insertion, with abruptly differentiated alar cells. Like *H. pratense,* it has large cortical cells. This character, found in several species of *Hypnum* in a more restricted sense, scarcely justifies the segregation of *H. lindbergii* and *H. pratense* as *Breidleria.*

2. **Hypnum pratense** Koch *ex* Spruce—Plants of medium size, in yellowish to golden, shiny mats. Stems ascending, subpinnately branched; cortical cells of stems and branches large and hyaline. Leaves erect-spreading and loosely complanate, with tips slightly to moderately curved-secund (especially so at tips of stems and branches), concave, often obscurely wrinkled-rugose when dry, about 2 mm. long, oblong-ovate, gradually acuminate, acute, somewhat decurrent; margins plane, usually serrulate at the tips; cells linear; basal cells shorter, wider, thick-walled, pitted, and yellowish, a few alar cells somewhat enlarged or inflated, not sharply delimited by obviously smaller cells. Dioicous. Setae 20-35 mm. long; capsules inclined to horizontal, curved and asymmetric, about 2.5 mm. long, not furrowed; annulus broad; operculum convex-conic, apiculate; cilia 2-3. Spores ca. 10-16 $\mu$, very finely papillose.—n = 9+1, 10.

Grout, Moss Flora of North America 3: Pl. 33 below. Jennings, Mosses of Western Pennsylvania, (ed. 2) Pl. 70 (as *Stereodon*).—**Fig. 925-927.**

A calciphile growing on wet soil or humus in open swampy places. Circumpolar; arctic America to British Columbia, Colorado, Michigan, and Pennsylvania.

CHEBOYGAN CO.—Douglas Lake, Reeses Bog, Vincent Lake. EMMET CO.—Arnott Lake. MACKINAC CO.—McKays Creek, Rexton Lake. PRESQUE ISLE CO.—Hammond Bay.

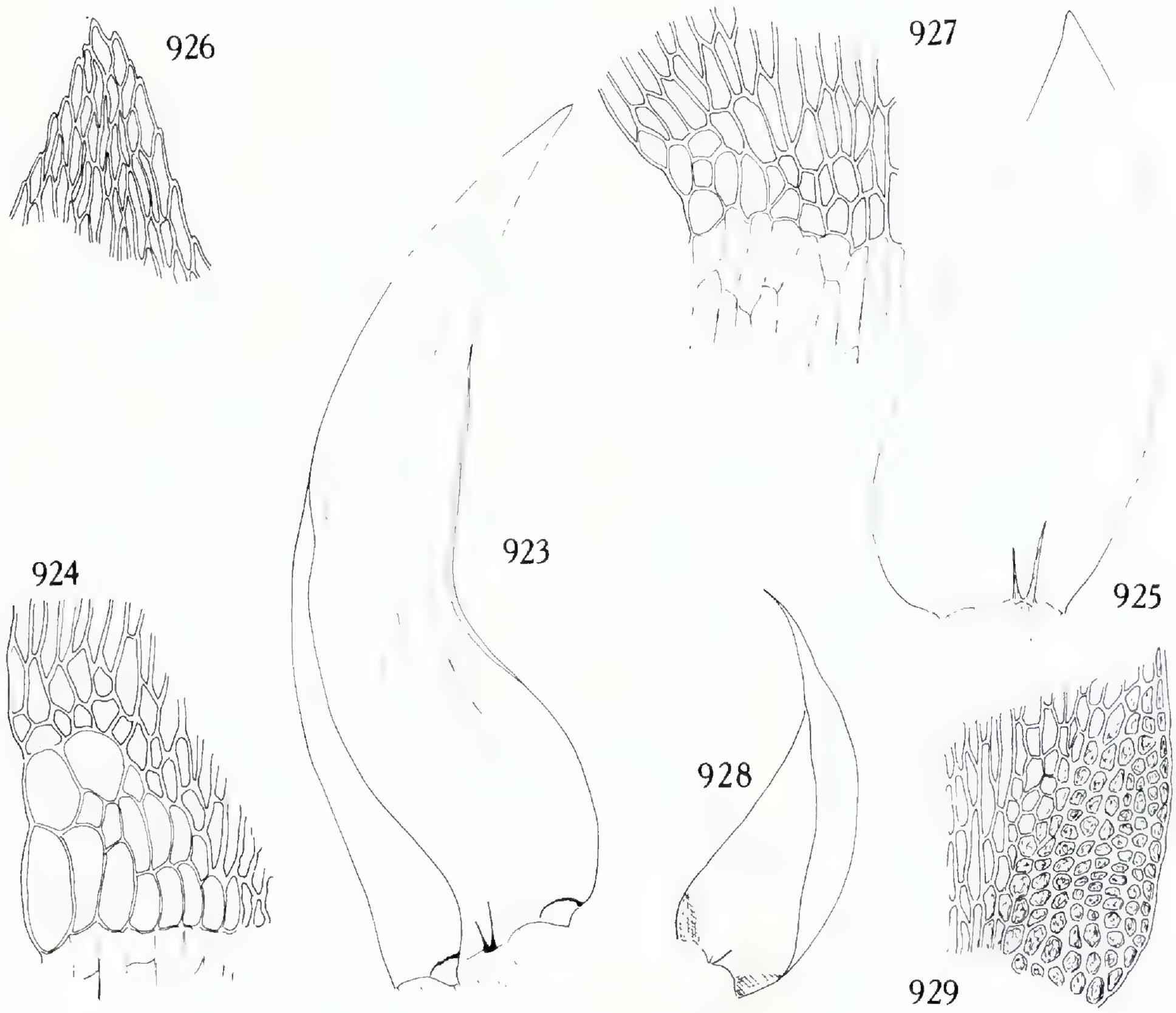
*Hypnum pratense* has been greatly misunderstood in this country, perhaps as a result of an unfortunate comparison with *Plagiothecium* given in Grout's *Moss Flora.* It is not likely to be confused with any species of *Plagiothecium,* although it is true that it has leaves somewhat more complanate and less hamate than those of *H. lindbergii,* from which it differs further in having leaves rounded to the insertion and alar cells smaller and less inflated in gradually differentiated groups.

*Hypnum curvifolium* has more regularly pinnate branching and more falcate-secund leaves with margins serrulate to well below the apex; also, its cortical cells are not noticeably large and hyaline.

3. **Hypnum cupressiforme** Hedw.—Plants in ± shiny, green, yellowish, or brownish mats. Stems creeping or ascending, freely and often pinnately branched; paraphyllia few, small, lanceolate. Leaves crowded, loosely imbricate, homomallous or falcate-secund, concave, oblong-ovate, or ovate-lanceolate, gradually or rather abruptly acuminate; margins erect, entire or serrulate above; upper cells rhomboidal to linear-rhomboidal, often thick-walled; alar cells many, small, quadrate, grayish-opaque. Dioicous. Setae up to 30 or 40 mm. long; capsules suberect and curved-cylindric; annulus present; operculum rostrate from a convex-conic base; cilia of endostome usually 1-2. Spores 18-20 $\mu$, finely papillose.—n = 10, 11, 16.

Conard, How to Know the Mosses, (ed. 2) fig. 283a-e. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 46 & (ed. 2) Pl. 50 (*Stereodon cupressiformis* var. *filiformis*).—**Fig. 928-929.**

On calcareous soil or rock, often in dry, exposed places. Nearly cosmopolitan; widespread in northern and montane regions in North America but not common in the East. Known from our area from a single collection on Mackinac Island, made by C. F. Wheeler, September 5, 1892 (*in herb.* Michigan State University). The record may be viewed with suspicion.




*Hypnum lindbergii.* 923. Leaf. 924. Alar cells.
*Hypnum pratense.* 925. Leaves. 926. Cells at leaf tip. 927. Alar cells.
*Hypnum cupressiforme.* 928. Leaf. 929. Alar cells.

Notoriously polymorphous in Europe but not causing much trouble in North America. It can be recognized by numerous small, quadrate, opaque alar cells. Plants may be green or brown but often have a characteristic grayish overcast. The crowded, imbricate, smoothly concave leaves with secund tips are recognizable to the practiced eye.

H. A. Miller has told me that *Hypnum cupressiforme* and allied species are often sold as "sheet moss" at Christmas time, even in modern supermarkets.

4. **Hypnum pallescens** (Hedw.) P.-Beauv.–Small plants in dark- or yellow-green, slightly shiny mats. Stems creeping, pinnately branched; paraphyllia few, small, lanceolate. Leaves crowded, erect-spreading and ± falcate-secund, 0.6-1 mm. long, concave, gradually or abruptly acuminate from an oblong-ovate base, acute; margins reflexed below, serrulate nearly throughout, more strongly so toward the apex; upper cells linear-rhomboidal (about 6-8:1), thick-walled; cells at the insertion shorter, wider, and yellowish; alar cells rather numerous, small, quadrate, thick-walled, ± opaque. Autoicous. Setae 6-13 mm. long; capsules suberect, curved-cylindric, about 1.5-2 mm. long; annulus present; operculum obliquely rostrate from a convex base; cilia usually paired, nodulose. Spores 12-13 $\mu$, finely papillose.–n = 10+1, 11; 2n = 22.

Conard, How to Know the Mosses, (ed. 2) fig. 285 (as *H. reptile*). Grout, Mosses with Hand-lens and Microscope, fig. 190 (as *H. reptile*), Moss Flora of North America 3: Pl. 33C. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 45 & (ed. 2) Pl. 49 (as *Stereodon reptilis*). Welch, Mosses of Indiana, fig. 195 (as *H. reptile*).–**Fig. 930-932.**

On bark at base of trees, less commonly on logs, rocks, and other substrata, in woods. Circumpolar; British Columbia to Nova Scotia, south to Arizona in the West, North Carolina in the East.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Colonial Point, Douglas Lake, Bryants Bog, Livingston Bog, Mud Lake, Mullett Lake, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.–Pellston Hills, Five Mile Creek, Wycamp Lake, Cecil Bay, Wilderness State Park, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Bush Bay, Cut River, Ozark, Hendricks, Little Dollar Lake. PRESQUE ISLE CO.–Presque Isle Lighthouse, Evergreen Beach, Hammond Bay, Mast Point, Rainy River Falls, Clinton Lake, Loon Lake.

Very common at the base of trees, especially hardwoods, where *Brachythecium reflexum, Platydictya subtile,* and *Homomallium adnatum* also grow, this species is recognized by its small size, falcate leaves with serrulate acumina, and margins recurved below. Grout tried to distinguish *H. pallescens* and *H. reptile* Mx. (largely on the basis of altitude and distribution), but the type specimens are essentially similar (and even if one wishes to recognize a specific difference, the names would need to be reversed in usage to conform to the type concepts).

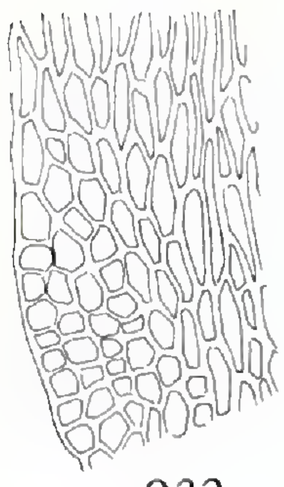
5. **Hypnum imponens** Hedw.–Plants fairly robust and handsome, in yellow-brown to yellow-green mats. Stems creeping, regularly pinnate, red-brown; paraphyllia relatively numerous, polymorphous, often lobed or dentate. Stem leaves about 2 mm. long, falcate-secund, concave, broadly oblong-triangular to oblong-lanceolate, slenderly acuminate, somewhat narrowed to the insertion or slightly auriculate, ± decurrent, smooth or slightly plicate when dry; margins serrulate in the upper half, usually reflexed near the base; upper cells linear with firm walls; cells at insertion oblong-linear, incrassate and porose, usually orange; alar cells quadrate, incrassate and somewhat opaque in rather conspicuous groups (usually about 4-6 cells along the margin), below them a few somewhat inflated, quadrate, clear or orange-brown cells. Branch leaves smaller with fewer quadrate alar cells. Dioicous. Setae 10-35 mm. long,

red; capsules 2.5-3 mm. long, cylindric, suberect, symmetric or slightly curved, smooth, red-brown; annulus none or narrow and poorly differentiated; operculum high-conic and sometimes shortly and stoutly rostrate; cilia of endostome single, variable in length, often well developed but fragile. Spores 15-22 $\mu$, very finely papillose.—n = 6-7, 7, 11.

Darlington, Mosses of Michigan, fig. 133. Grout, Mosses with Hand-lens and Microscope, fig. 184b, d, 185. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 45, (ed. 2) Pl. 49 (as *Stereodon*). Welch, Mosses of Indiana, fig. 191.—**Fig. 933-937.**

Typically on rotten logs but often on rocks, humus, or bark at base of trees in moist woods. Europe and Asia; Yukon; Newfoundland to Wisconsin and south to the Gulf of Mexico.

CHEBOYGAN CO.—Reeses Bog, Gorge of Carp Creek, Iron Bridge, Livingston Bog, Mud Lake, Weber Lake. EMMET CO.—Carp Lake, Five Mile Creek, Mackinaw City Hardwoods, Big



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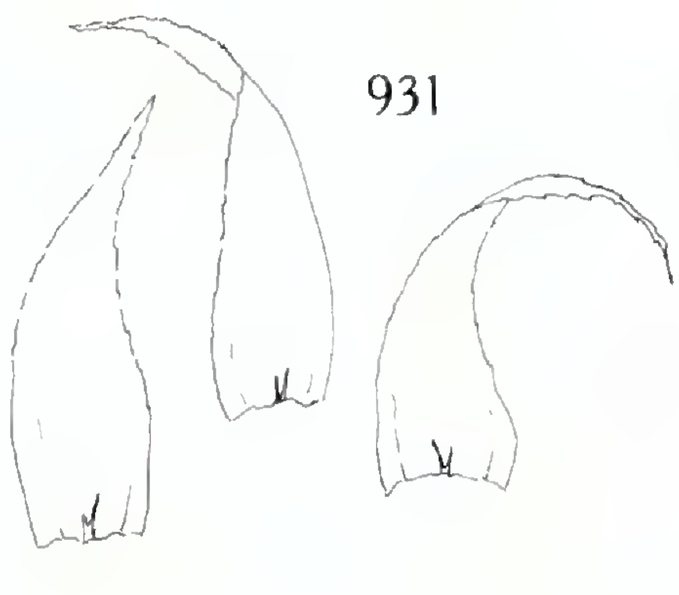

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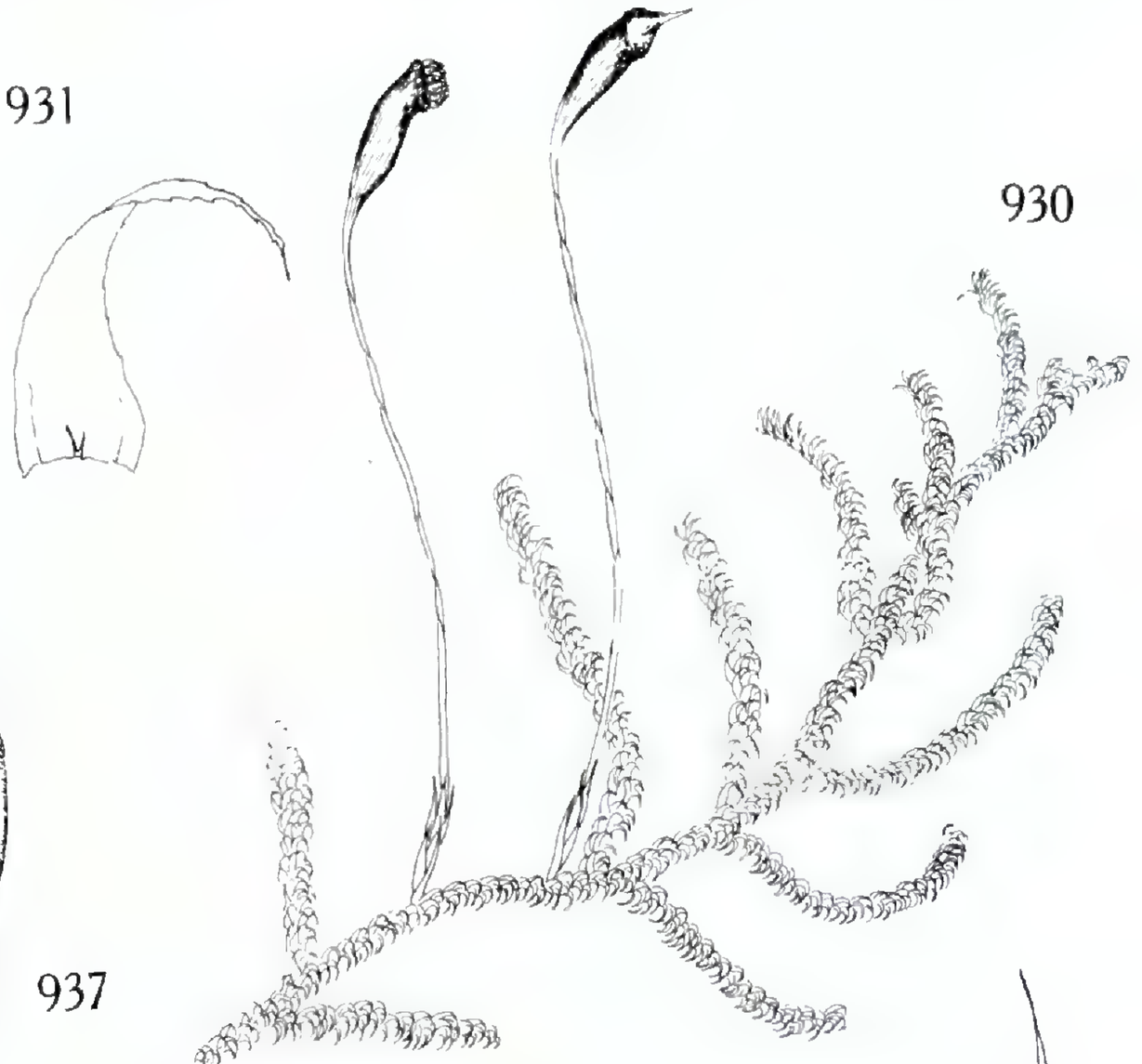

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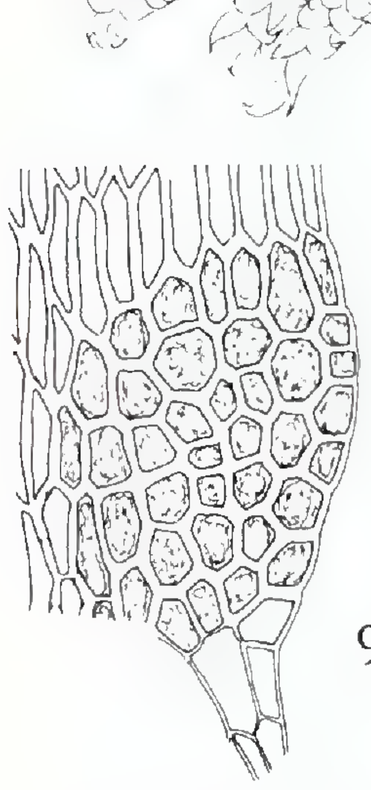

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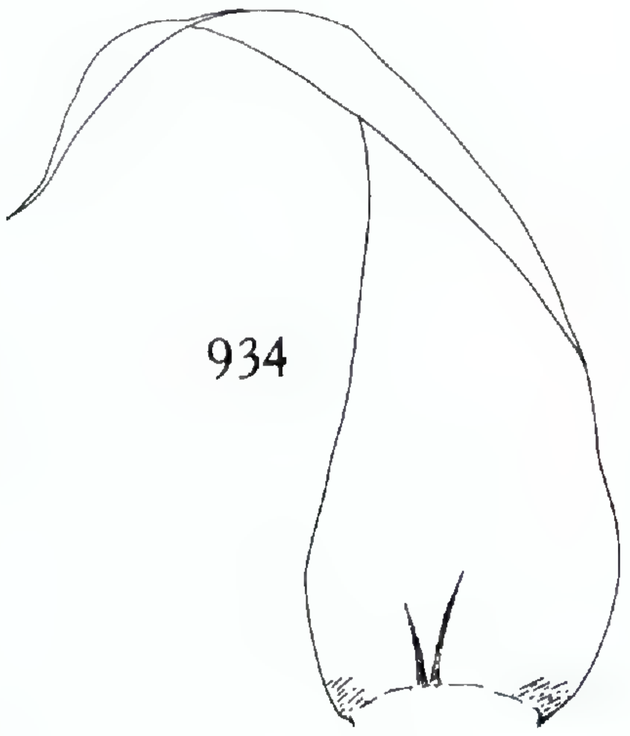


934

936

*Hypnum pallescens.* 930. Habit. 931. Leaves. 932. Alar cells.
*Hypnum imponens.* 933. Habit. 934. Leaf. 935. Alar cells. 936. Paraphyllia. 937. Capsule.

Stone Creek. MACKINAC CO.–Prentiss Bay, Cut River, McNamara Pond. PRESQUE ISLE CO.–Lamprey Experiment Station, Evergreen Beach, Hoeft State Park.

*Hypnum imponens* has red-brown stems and, for the genus, relatively numerous, often branched paraphyllia. The leaves are not much narrowed to the insertion (as compared with *H. curvifolium*), and the rather thick-walled, orange-brown, quadrate alar cells are distinctive, as are the suberect capsules.

Mat-forming mosses, such as *Hypnum imponens,* are important in forest seeding. In the Great Lakes region, sugar maples ordinarily spring up in countless numbers in upland forests that have been clean cut, occupying the surface to the exclusion of all other tree species and thus completely controlling succession. But sugar maple seedlings will not grow on logs. If logs are left behind after cutting, they provide habitats favorable to the establishment of hemlock and yellow birch in mixture with maple. (See also the discussion of *Polytrichum juniperinum,* which may serve in the re-forestation of pasture lands by providing a seed bed.)

6. **Hypnum curvifolium** Hedw.–Plants relatively robust, in yellow-green to brownish (rarely light-green), ± shiny, flat mats. Stems prostrate, orange-brown or reddish, regularly pinnate; cortical cells not enlarged; pseudoparaphyllia none. Stem leaves smooth, falcate-secund, triangular-ovate, gradually narrowed to a relatively broad acumen, abruptly rounded at the insertion and somewhat decurrent; margins plane or erect, serrulate at the apex and sometimes sinuate-serrulate in the upper third or more, sinuolate near the base; cells linear-flexuose above, shorter, broader, porose, and often yellow or orange at the insertion, at the basal angles a few hyaline, thin-walled, inflated cells forming short decurrencies, above them a few, small and inconspicuous, short-oblong cells. Apparently dioicous. Setae 20-47 mm. long, orange-yellow; capsules 2.5-3 mm. long, strongly curved, obovoid-cylindric from a tapered neck, furrowed when dry and empty; annulus broad, persistent; operculum convex-conic, apiculate; cilia in 2's and 3's, well developed, nodulose. Spores 18-24 $\mu$, very finely papillose.

Conard, How to Know the Mosses, (ed. 2) fig. 281. Grout, Mosses with Hand-lens and Microscope, fig. 187. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 46 & (ed. 2) Pl. 50 (as *Stereodon*). Welch, Mosses of Indiana, fig. 193.–**Fig. 938-940.**

On rocks, soil, logs, or bark at base of trees in moist or wet, shaded places. Japan; widespread in eastern North America.

MACKINAC CO.–Mackinac Island.

The broadly acuminate leaves are abruptly narrowed to a shortly decurrent base. The few cells of the decurrencies are somewhat enlarged, thin-walled, and hyaline. The curved and strongly inclined capsules are plicate when dry and empty.

7. **Hypnum fertile** Sendtn.–Plants relatively slender, in soft, yellow-green or yellow-brown, flat mats. Stems prostrate, orange or brownish, closely and evenly pinnate; cortical cells somewhat enlarged; pseudoparaphyllia at branch insertions. Stem leaves smooth, falcate-secund, about 1.5-2 mm. long, concave, oblong-lanceolate, very slenderly long-acuminate, somewhat rounded to the insertion and decurrent; margins erect, entire or somewhat serrulate near the apex; cells long-linear, flexuose, somewhat thicker-walled and ± porose at the insertion; alar cells oblong, thin-walled, inflated, and hyaline in small decurrencies bordered above by a small group of small, obscure cells. Branch leaves similar but smaller, with broader acumina, serrulate in the upper half. Autoicous. Setae 13-25 mm. long, reddish, flexuose; capsules 2-2.2 mm. long, hori-

zontal, curved and asymmetric, oblong-cylindric, smooth or somewhat furrowed when dry and empty; annulus revoluble; operculum conic, blunt or acute; cilia of endostome in 2's, well developed, nodose or appendiculate. Spores 11-13 $\mu$, very finely papillose.—n = 11.

Grout, Mosses with Hand-lens and Microscope, fig. 189. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 45 & (ed. 2) Pl. 49 (as *Stereodon*).—**Fig. 941-942.**

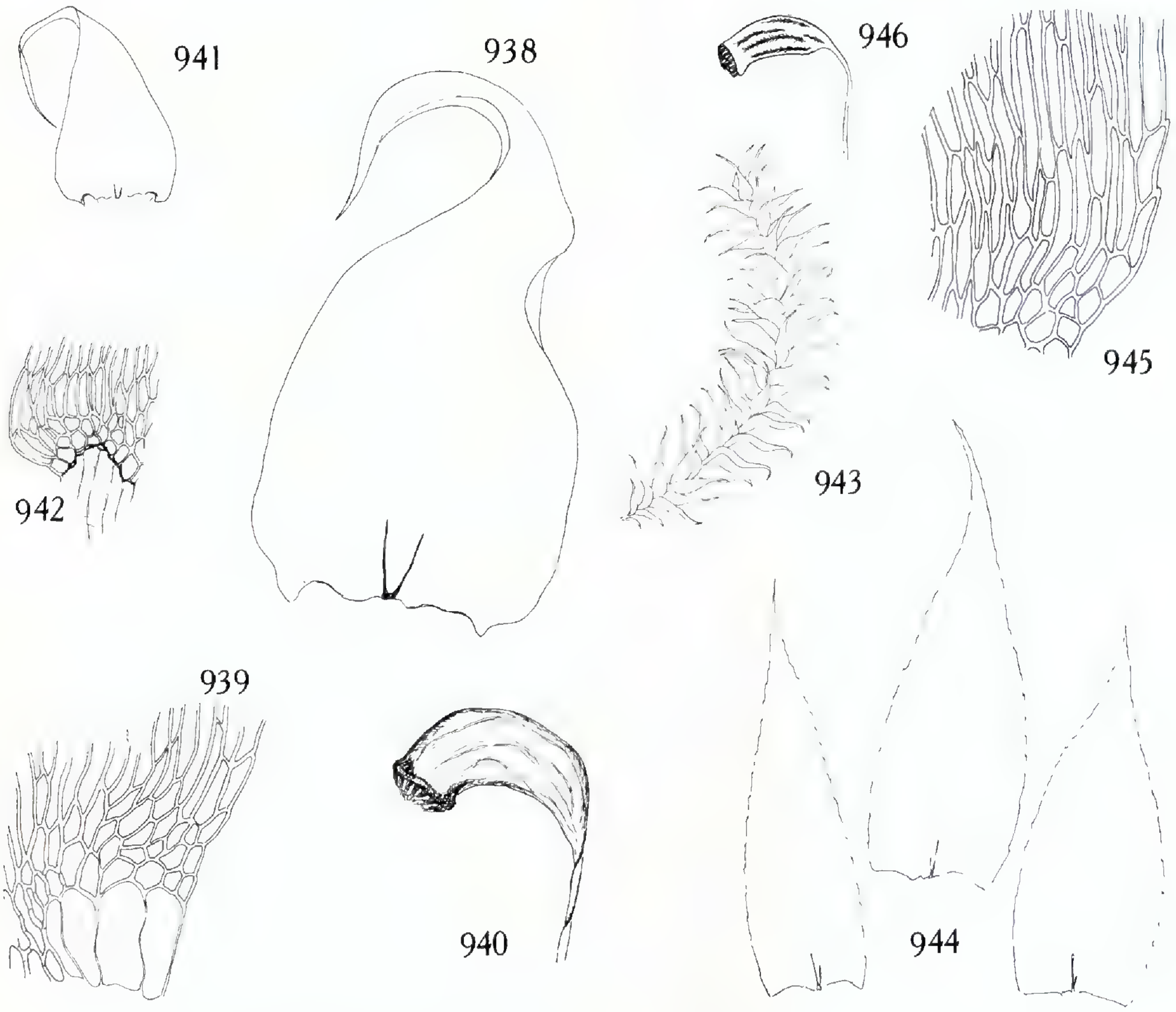
On rotten logs in woods. Europe and Asia; Labrador to Manitoba, south to Michigan and Tennessee.

CHEBOYGAN CO.—Colonial Point, Little Lake 16.

Smaller than *H. curvifolium,* with more slenderly acuminate leaves which are not rounded to the insertion. A few cells at the extreme basal angels of the leaves are somewhat inflated, hyaline, and thin-walled, and the cortical cells are rather large.

## 8. **Herzogiella** Broth.

Plants of rather small size in loose or dense, shiny, green, yellowish, or brownish mats. Stems creeping, freely and irregularly branched; branches spreading or ascending; cortical cells large and thin-walled; pseudoparaphyllia none; brood-bodies none. Leaves




*Hypnum curvifolium.* 938. Leaf. 939. Alar cells. 940. Capsule, dry.
*Hypnum fertile.* 941. Leaf. 942. Alar cells.
*Herzogiella turfacea.* 943. Habit. 944. Leaves. 945. Cells of alar region. 946. Capsule, dry.

of stems and branches similar, wide-spreading and not or loosely complanate, ovate or oblong-lanceolate, slenderly acuminate, not or strongly decurrent; margins plane, serrulate in the upper 1/2-2/3; cells linear, scarcely differentiated at the basal angles or hyaline, thin-walled, and inflated in small but distinct, decurrent alar groups. Autoicous. Setae smooth; capsules suberect to strongly inclined, oblong-cylindric, becoming curved-cylindric, constricted below the mouth, and plicate when dry and empty; annulus well developed; operculum bluntly low-conic; stomata at base of the urn; peristome yellowish or yellow-brown and cross-striolate below, hyaline and papillose above, bordered, trabeculate; endostome hyaline, finely papillose, with a high basal membrane, keeled, non-perforate segments, and nodulose, single or paired cilia. Calyptrae naked.–Named for Theodor Herzog, distinguished bryologist and author of *Die Geographie der Moose.*

**Herzogiella turfacea** (Lindb.) Iwats.–Rather small, yellow- or bright-green plants in loose mats. Branches spreading. Leaves wide-spreading and loosely and indistinctly complanate, often ± secund at the tips, sometimes somewhat plicate when dry, 1.2-1.5 mm. long, oblong-lanceolate, gradually narrowed to a long, flexuose acumen, not decurrent; cells linear-flexuose, scarcely differentiated at the basal angles. Perichaetial leaves flexuose or spreading at the tips. Setae 8-18 mm. long, red; capsules strongly inclined and horizontal, 1.5-2 mm. long; peristome teeth yellowish; cilia of endostome paired. Spores 9-11 $\mu$, minutely roughened.–n = 11, 11+1.

Grout, Mosses with Hand-lens and Microscope, Pl. 83 (as *Plagiothecium*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 47 & (ed. 2) Pl. 51 (as *Isopterygium*).–**Fig. 943-946.**

On rotten logs and stumps, less commonly on humus or bark at base of trees, in moist, coniferous woods. Europe and Asia; Newfoundland to South Dakota, south to Michigan, Ohio, and South Carolina.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Burt Lake, Bryants Bog, Livingston Bog, Mud Lake, Mullett Lake, Duncan Bay, Grass Bay, Little Lake 16. EMMET CO.–Arnott Lake, Galloway Bog, Pleasantview Swamp, Wycamp Lake, Wycamp Creek, Cecil Bay, Conway Bog, Five Mile Creek, Ramona Beach. MACKINAC CO.–Bois Blanc Island, Mackinac Island, Epoufette, Little Dollar Lake. PRESQUE ISLE CO.–Ocequeoc River, Lamprey Experiment Station, Evergreen Beach, Clinton Lake.

The plants are easily recognized but difficult to characterize. The narrow, wide-spreading leaves give an impression of being complanate with somewhat decurved tips, but they are really loosely arranged and on inspection seem scarcely complanate at all.

**Herzogiella striatella** (Brid.) Iwats., a species of more northern or montane distribution, occurs at the Upper Falls of the Tahquamenon River in Luce County and also at the Lower Falls in Chippewa County (and elsewhere in the Lake Superior region). It has leaves spreading from an erect base, not or obscurely flattened and not at all secund, with abruptly inflated, decurrent alar cells.

## 9. **Ctenidium** (Schimp.) Mitt.

Plants rather small or medium-sized, in dense, soft, green, yellowish, or golden-brown, shiny mats. Stems creeping or more crowded and ascending, pinnately branched; branches short; paraphyllia few, at branch insertions. Stem and branch leaves differentiated: Stem leaves crowded, spreading to squarrose or squarrose-recurved and usually ± secund at the tips, smooth or somewhat plicate, symmetric, abruptly acuminate from an ovate-cordate, broadly decurrent base, distinctly serrate all around;

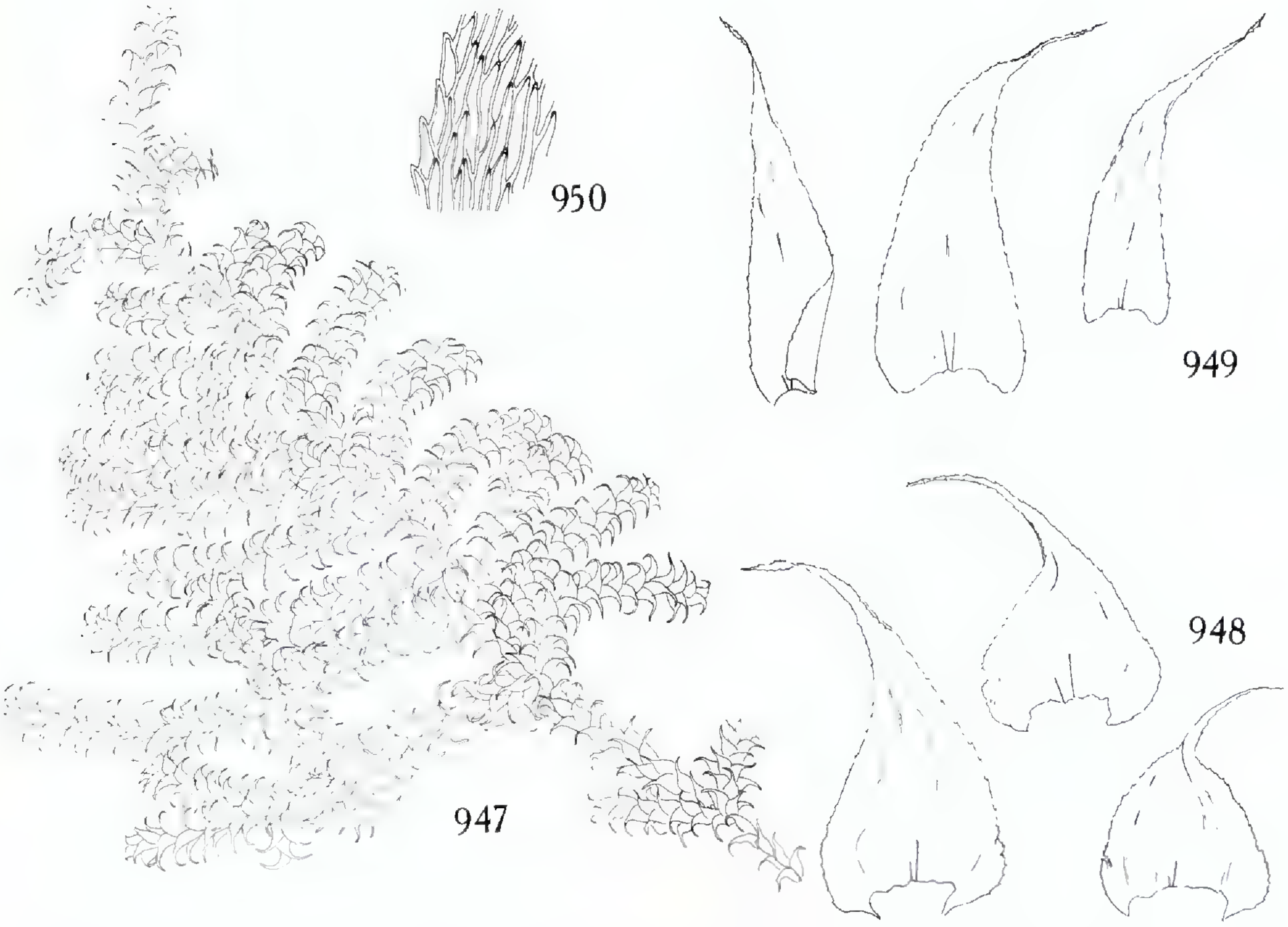
cells linear above, subquadrate in the decurrencies. Branch leaves loosely falcate-secund, smaller, lanceolate, gradually acuminate, only slightly decurrent, with upper cells papillose at back because of projecting upper angles. Dioicous; perichaetial leaves erect, oblong, with abruptly acuminate tips. Setae smooth or ± papillose; capsules strongly inclined to horizontal, oblong-cylindric, not or somewhat narrowed below the mouth when dry, smooth; annulus present; operculum conic, sometimes apiculate; peristome teeth cross-striolate below, papillose above, bordered and trabeculate; endostome densely and finely papillose, with a high basal membrane, keeled and not or somewhat perforate segments, and nodose cilia in groups of 2-3. Calyptrae usually ± hairy.—The name means comb-like, branched in a pectinate manner.

**Ctenidium molluscum** (Hedw.) Mitt.—Stem leaves 1.2-2 mm. long. Branch leaves about 1-1.4 mm. long. Phyllodioicous. Setae 13-20 mm. long, smooth, red-yellow, becoming red with age; capsules about 2 mm. long; operculum apiculate; stomata in the neck. Spores 11-15 $\mu$, very finely papillose. Calyptrae very sparsely hairy.—n = 7, 8, 10.

Conard, How to Know the Mosses, (ed. 2) fig. 280 (as *Hypnum*). Darlington, Mosses of Michigan, fig. 139. Grout, Mosses with Hand-lens and Microscope, fig. 183 (as *Hypnum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 42, (ed. 2) Pl. 46. Welch, Mosses of Indiana, fig. 196 (as *Hypnum*).—**Fig. 947-950.**

On soil or humus and rock, sometimes on decayed wood, locally on the floor of *Thuja* swamps. Europe, North Africa, Macaronesia, and Asia; Newfoundland to Michigan, south to South Carolina and Louisiana.

CHEBOYGAN CO.—Iron Bridge. EMMET CO.—E. of Woodland School, Arnott Lake.




*Ctenidium molluscum*. 947. Habit. 948. Stem leaves. 949. Branch leaves. 950. Cells of upper part of branch leaf.

Rather small mosses of a soft, feathery appearance, notable for the cordate-triangular, broadly decurrent, and abruptly acuminate stem leaves and leaf cells minutely papillose at the upper angles at back.

## 10. **Ptilium** De Not.

Robust, strikingly handsome plants in extensive, bright-green, yellow, or golden, shiny mats. Stems erect-ascending, at least toward the tips, simple or forked, regularly 1-pinnate, forming flat, oblong or oblong-triangular fronds whcih are hooked or rolled at the tips; branches crowded, horizontally spreading, hooked at the tips; paraphyllia few, at branch bases. Stem leaves considerably larger than branch leaves, loosely falcate-secund, broadly triangular-ovate, gradually long-acuminate, plicate; margins plane, serrulate above; cells smooth, long-linear, flexuose, those at the insertion shorter, broader, incrassate, and porose, a few cells at the basal angles short-rectangular, pale and thin-walled in inconspicuous groups. Branch leaves circinate and secund, plicate, oblong-lanceolate, slenderly long-acuminate; margins irregularly revolute below, serrulate above; costa short and double or lacking; cells at insertion and at basal angles only poorly differentiated. Dioicous; perichaetial leaves very long, erect, lance-subulate. Setae smooth; annulus narrow; operculum conic, apiculate; peristome teeth cross-striolate and bordered below, papillose above, trabeculate; endostome pale, papillose, the basal membrane high, segments broad, keeled, not or narrowly perforate, cilia well developed, nodulose. Calyptrae naked.—The name refers to a plume-like appearance.

**Ptilium crista-castrensis** (Hedw.) De Not.—Plants 3.5-11 cm. high, beautifully plumose, green to golden, shiny. Stem leaves 2-3 mm. long. Branch leaves 1.2-2 mm. long. Setae 25-45 mm. long, reddish; capsules nearly horizontal, 2-3 mm. long, chest-nut-brown; peristome teeth dark, reddish-brown; endostome pale-yellow; cilia in groups of 2 or 3, rarely single. Spores 12-16 $\mu$, smooth or very finely papillose.—n = 9+1, 10, 10+1, 11, 20.

Conard, How to Know the Mosses, (ed. 2) fig. 279 (as *Hypnum*). Darlington, Mosses of Michigan, fig. 138. Grout, Mosses with Hand-lens and Microscope, figs. 181, 182, 184a,c,e (all as *Hypnum*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 45, (ed. 2) Pl. 49.—**Fig. 951-953.**

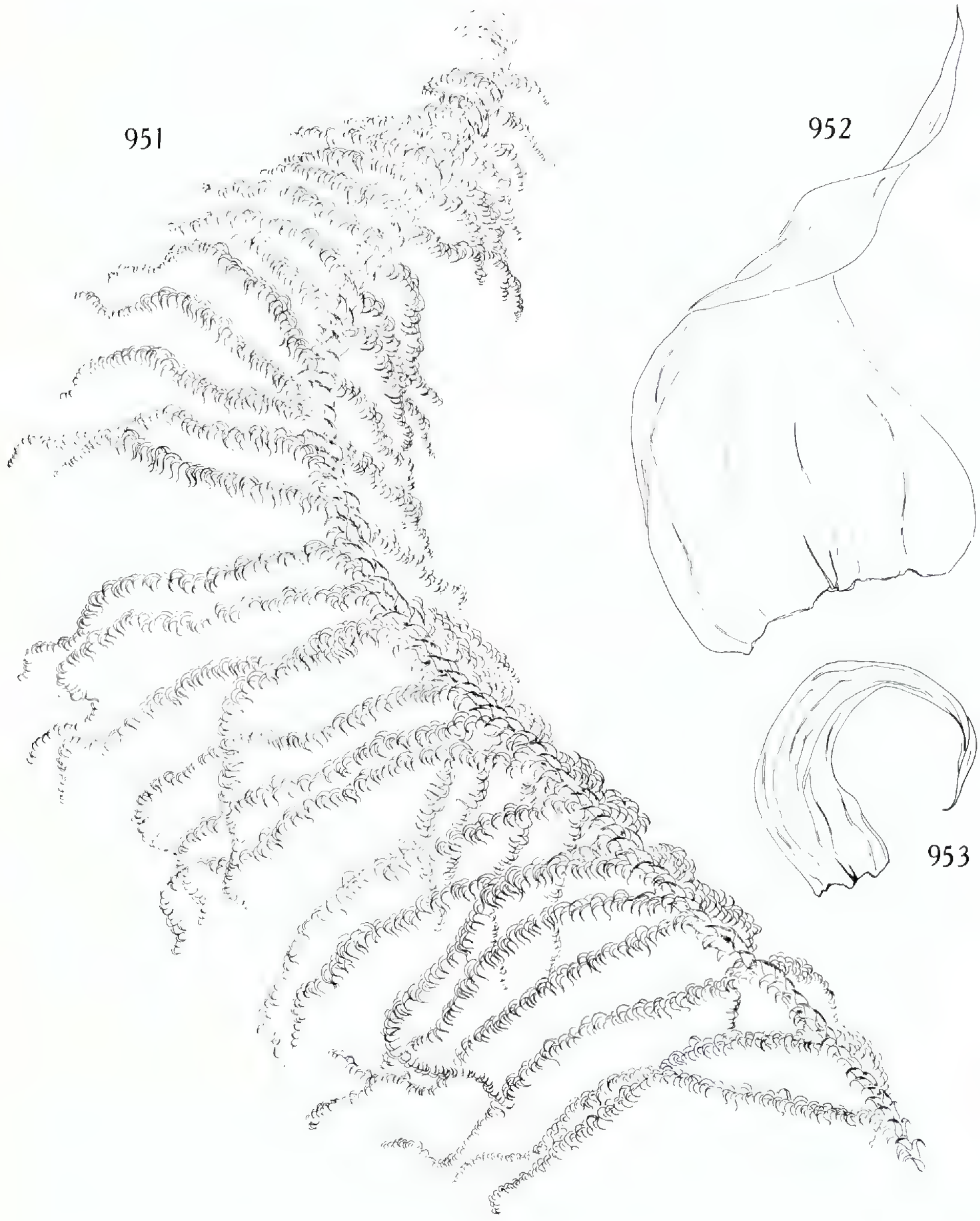
On humus and old mossy logs in moist forests. Circumpolar; Alaska to Newfoundland, south to Oregon, Montana, Iowa, Michigan and North Carolina.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek. EMMET CO.—Levering, Galloway Bog, Maple River, Stutsmanville, Middle Village, Wycamp Lake, Cecil Bay, Big Stone Bay, Conway Bog. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, Epoufette, Rexton Lake, Ozark, McKays Creek. PRESQUE ISLE CO.—Lamprey Experiment Station.

A truly splendid moss, appropriately called the KNIGHT'S PLUME. The shiny, feathery fronds curved at the tips, with clearly plicate leaves, are distinctive, although the species is similar in many ways, including the elongate perichaetium, to *Drepano-cladus uncinatus.* In rare cases of doubt, the single costa of the *Drepanocladus* will decide the matter.

In the *Popular History of British Mosses* (1860), Stark referred to *Ptilium crista-castrensis* as "one of the prizes which botanical tourists should endeavour to carry south, as a remembrance of the land of brown heath and shaggy wood, for its graceful feathery branches suit admirably either for the scientific cabinet or the drawing-room scrapbook."

The specific epithet would seem to have an ending grammatically out of agreement with the generic name. *Crista* (a crest) is actually a noun in apposition




*Ptilium crista-castrensis.* 951. Habit. 952. Stem leaf. 953. Branch leaf.

rather than a simple epithet and *castrensis* (castle or fort) agrees with it rather than with *Ptilium*.

It has been erroneously stated that this moss is figured in the coat of arms of the Dukes of Lancaster. Similar looking plumes are featured there and in numerous other devices of heraldry, but not mosses!

## CLIMACIACEAE

Rather large, gregarious mosses on swampy soil. Primary stems subterranean and rhizome-like, tomentose; secondary stems typically erect and dendroid; branches simple

or 1-2-pinnate, densely foliate, terete, ± attenuate; paraphyllia abundant, filiform, simple or branched. Leaves of primary stems and bases of secondary stems appressed and scale-like. Upper leaves of secondary stems and branches oblong-ovate to subcordate, blunt or acute, ± auriculate at base, ± plicate, toothed at least above; costa single, strong, broad at base, ending below the apex; cells smooth, rhomboidal to linear above, with firm or thick walls, colored and ± porose at base, scarcely to clearly differentiated at the basal angles. Dioicous; perichaetia on secondary stems and bases of branches; perichaetial leaves long-sheathing. Setae elongate, sometimes clustered; capsules cylindric, smooth, erect and symmetric or curved and strongly inclined; annulus none; operculum rostrate from a convex base; stomata in the neck; peristome double, the 16 teeth lanceolate, red-brown, papillose or cross-striolate, bordered, trabeculate; endostome about as long as the teeth, the basal membrane very low to fairly high, segments keeled and narrowly perforate along the middle to gaping and finally split to the apex, cilia none. Calyptrae cucullate.

### **Climacium** Web. & Mohr

Plants dull, dark-green or yellow-brown, typically erect and dendroid. Branch leaves oblong-ovate to subcordate, bluntly acute to short-acuminate, coarsely toothed above, ± decurrent and auriculate at base; costa toothed at back above; cells rhomboidal to linear, colored and pitted at the insertion, not much differentiated at the basal angles. Setae single or clustered; capsules erect and symmetric; peristome teeth dark-brown, papillose; endostome yellowish, with a very low basal membrane and linear segments papillose in vertical lines, gaping and finally split along the median line. Spores spherical. Calyptrae covering the entire capsule, somewhat twisted.—The name refers to the broad perforations of the endostome segments which suggest a ladder.

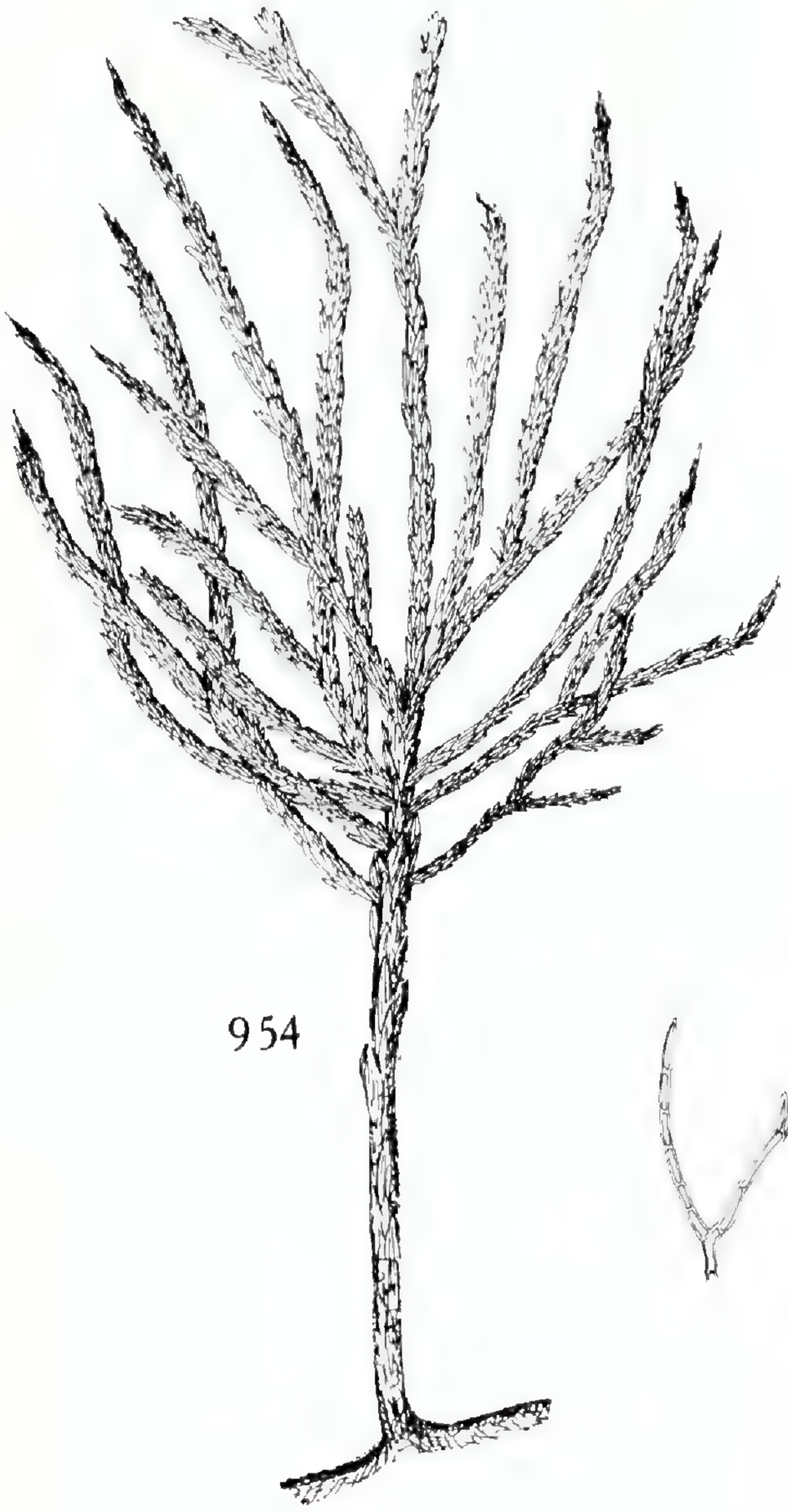
**Climacium dendroides** (Hedw.) Web. & Mohr—Plants shiny when dry, yellow or yellow-green, rather soft, 3-9, rarely 13 cm. high. Branch leaves erect, nearly smooth to sulcate, 2-3 mm. long, ovate or ovate-lanceolate, ± rounded above the insertion but not or only slightly auriculate; upper median cells 5-9:1, oblong-rhomboidal; alar cells pale, thin-walled, and slightly inflated in small and inconspicuous groups. Setae 18-45 mm. long; capsules 1.5-3 mm. long, oblong-cylindric; operculum ± rostrate. Spores 13-22 $\mu$, minutely papillose.—n = 9+2, 11.

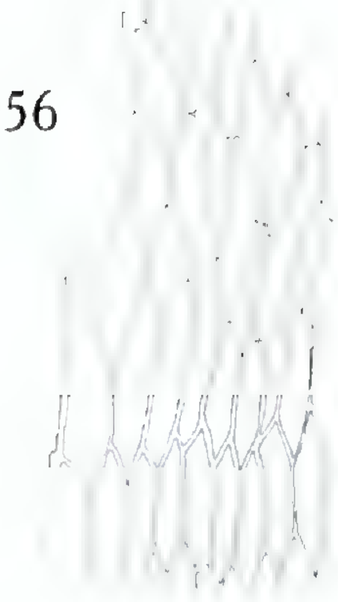
Conard, How to Know the Mosses, (ed. 2) fig. 195d-e. Darlington, Mosses of Michigan, fig. 94. Grout, Mosses with Hand-lens and Microscope, fig. 158d-e, 159a. Welch, Mosses of Indiana, fig. 134.—**Fig. 954-958.**

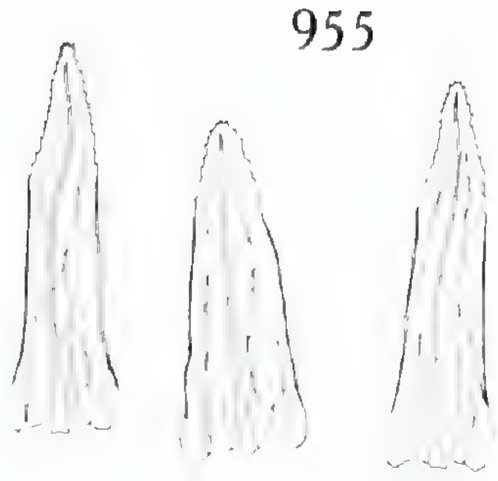
On soil or humus in shady, swampy places. Circumpolar; Alaska to northern Quebec, south to Pennsylvania, Wisconsin, New Mexico, Arizona, and California.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Carp Creek, Iron Bridge, Smiths Bog, Vincent Lake, Fontinalis Run, Bessey Creek, Douglas Lake, Colonial Point, Mud Lake, Grass Bay, Weber Lake. EMMET CO.—Maple River, Pleasantview Swamp, Levering, Galloway Bog, Cross Village, Cecil Bay, Big Stone Bay, Conway Bog. MACKINAC CO.—Bois Blanc Island, St. Martins Point, Hog Island Point, Epoufette, McNamara Pond, Hendricks, Peggley Lake, Round Island, McKays Creek. PRESQUE ISLE CO.—Mast Point, Lamprey Experiment Station, Clinton Lake, Rainy Lake.

*Climacium dendroides,* commonly known as the TREE MOSS, has a broad, northern distribution overlapping in eastern North America with the more southerly **C. americanum** Brid., which differs as follows: Plants dull and dirty-green, with auriculate branch leaves with shorter upper cells (2-5, rarely 7:1) and longer, cylindric capsules (3.5-6 mm. long). Both species occur in southern Michigan. Sporophytes are rare in either species.








*Climacium dendroides.* 954. Habit. 955. Leaves. 956. Upper cells of leaf. 957. Paraphyllia. 958. Capsule.

**Climacium kindbergii** (Ren. & Card.) Grout is an irregularly branched form of *C. americanum* induced by flooding.

**Thamnobryum alleghaniense** (C. M.) Nieuwl. resembles a stepped-on *Climacium*, but the branches are drooping and swept to one side, and there are no paraphyllia. It is characteristic of sandstone areas and may be discovered in the Lake Superior region.

*Climacium* and other mosses have been used in decorating women's hats, but as Frances Tripp (*British Mosses* . . . 1888) observed, not very well: "And a lady's cap which we saw in a window was in no wise adorned by having sprays of artificial moss tacked all over it . . . Nor is a bunch of moss which has died of thirst suitable for trimming a bonnet. The chief beauty bonnets at present possess is their being fresh and clean; dry moss is particularly fusty looking, and it is not improved by being dyed of a leather color(!!), or a violent blue-green (!!!), the latter being the worst, as a bad match, for moss is *never* a blue-green."

The economic uses of bryophytes, decorative and otherwise, are recorded by Ando (Jour. Biol. Soc. Hiroshima Univ. 7: 23-26. 1957), Nelson & Carpenter (Econ. Bot. 19: 70. 1965), Stark (*British Mosses,* ed. 2, 1860), Thieret (Bull. Chicago Nat. Hist. Mus., Sept. 1954, pp. 4, 6; Econ. Bot. 10: 75-91. 1956), and Welch (Proc.

Indiana Acad. Sci. 58: 31-46. 1948). There is no dearth of information on uses of *Sphagnum* (which see).

The studied simplicity of Japanese moss gardens approaches the Zen Buddhist ideal of beauty–nothingness. Avery's essay (Plants & Gardens 22: 44-48. 1967) provides insight into the meaning of Japanese gardens in general. Iwatsuki & Kodama (Econ. Bot. 15: 264-269. 1961) give an informative bryological review of moss gardens. Other information is provided by Ando (Plantes de Mont. 5: 290-294. 1971), Pullar (Plants & Gardens 22: 32-33. 1967), Schofield (Davidsonia 1: 18. 1970), and Steere (Garden Jour. 18: 2-11. 1968).

In *Sunset Ideas for Japanese Gardens* (edited by Jack McDowell), directions are given for starting moss cultures (p. 69). Partially dried moss is crumbled over a layer of cheesecloth overlying a sand-peatmoss mixture (or sawdust) in a flat. A second piece of cheesecloth is laid on top and kept moist. In about 4½ months the double layer of cloth with attached moss can be lifted out as an interwoven turf and cut into pieces which can be plastered with mud or wired in place for growth. I have found that vermiculite is better, because organic substrates so quickly mold. I recommend using ecologically undemanding perennials, such as *Mnium cuspidatum* or *Brachythecium salebrosum.* New growth formed by regeneration works better than mats transplanted from nature. Constant humidity and indirect lighting (under a greenhouse bench, for example) favor growth of cultures.

Forman (Bryol. 71: 344-347. 1968) reported that caloric values of 13 mosses from Mt. Washington, New Hampshire, are among the lowest in the ecosystem. Such values may be related to a low metabolic rate, evidenced by slow growth to a small size, and also to a virtual lack of tissue differentiation providing for food storage. On the other hand, Sugawa (Hikobia 2: 119-124. 1960) found some food value in *Barbella pendula* (Sull.) Fi. He found it rich in vitamin $B_2$, in dry and living states. On adding powdered material to food given to puppies and chickens, he noted no distaste for the mixtures and no ill effects. In fact, animals so fed gained more weight than those in a control series. (The sample was, however, very small.)

Robert Pegau has told me, in correspondence, that reindeer herded in Alaska scarcely digest mosses at all, although lichens (which have high food values) are readily digested.

In nature animals rarely eat bryophytes, possibly because of their taste! Mizutani (Misc. Bryol. et Lichen. 2: 100. 1961) reported that 12 out of 95 dried specimens of the liverwort *Jamesoniella autumnalis* were so bitter that gargling was necessary to wash the taste from the mouth. Other specimens were less bitter, and some not at all, there being some apparent geographic pattern in the phenomenon in Japan. Another liverwort, *Porella vernicosa,* had a terrible taste, difficult to describe, in both dry and fresh conditions. A moss, *Rhodobryum giganteum,* had a sickening sweetness in fresh but not dry material; this taste too had to be rinsed from the mouth.

Most mosses in eastern North America have an unpleasant taste, something like raw green beans and, when strong, rather peppery and distinctly unpleasant, rarely even nauseating. Most species of *Dicranum* have a strong taste, and that of *Rhodobryum roseum* is very unpleasant and long-lasting. Leafy liverworts often have a slight medicinal flavor, something like witch hazel or camphor. I have not sampled enough of the thallose liverworts to generalize. *Preissia quadrata* is hot enough to tingle the tip of the tongue and burn the back of the mouth. *Conocephalum conicum* has a spicy-sweet smell, not registering in the mouth as a taste, however. *Sphagna* generally have a slight fishy-oily taste. I find some variation between specimens, here and there, but no patterns of geographic differentiation. Nor do I taste anything other than straw-flavors in dry material!

Skin rashes sometimes affecting forest workers, known as cedar, spruce, or wood poisoning, have been traced to such lichen substances as usnic acid. A similar rash may

be caused by contact with certain liverworts, especially species of *Frullania* and apparently other bryophytes, including mosses, as well (Mitchell *et al.*, Arch. Derm. 100: 46-49. 1969).

Edible or not, bryophytes do have importance in nature, in providing shelter to small animals or seed beds for other plants, in controlling erosion and flooding, and in altering drainage and preserving permafrosted conditions of arctic soils.

Water bears (tardigrades) may be associated with mosses or lichens on the bark of trees and elsewhere. Such an association may only express a similar ability to withstand frequent drying. It was reported by Felföldy and Iharos (Borbasia 7: 31-38. 1947) that tardigrades are associated with *Didymodon tophaceus* but only in tufts above the wet zone at lake shores in Hungary; they believed that it was not the species of moss but the uniformity of conditions offered by the tufts that favored the tardigrades. Richards (Trans. Brit. Bryol. Soc. 1: 16. 1947) reported that *Fontinalis antipyretica,* introduced into South Africa to harbor small crustaceans as food for trout, had an adverse effect on the larvae of aquatic insects. The associations of arthropods and bryophytes are reviewed by Gerson (Bryol. 72: 495-500. (1969) 1970).

But all uses aside, who can measure the comfort that mosses and liverworts add to a cheerless planet, just by being?

> "The Mosses are humble plants, but they have no insignificant part to play either in the economy of Nature or in the physiognomy of the landscape. Trees, walls, rocks, and ruins assume a smiling or picturesque aspect under their covering in its varied colours."
>
> Fiquier, *The Vegetable World,* 1872.

I like Frances Tripp's observation (in *British Mosses* . . . 1888): "It is in winter, and in earth's barren spots, that the moss best flourishes. Is it not a type of the countless *little* mercies, which. in times of trial, are often sent to us?" But her prose got purple: "Mosses are useful to the insect tribe, countless numbers of which find homes among their branches, and roam about in their shades as in mighty forests, looking with their thousand eyes upon the wonders of their leaves, and sunning their wings of purple and of gold, and burnishing their shining armour upon the polished columns of their urns."

## HYLOCOMIACEAE

Rather robust plants in loose mats or tufts. Stems creeping or erect-ascending, sparsely to pinnately branched, sometimes frondose; paraphyllia none, few, or many. Leaves crowded in several rows, ± concave, symmetric, broadly ovate to oblong-lanceolate, broadly acute to gradually or abruptly ± long-acuminate, sometimes plicate or rugose; costa single or double and fairly elongate, often slender or weak, sometimes papillose at back because of projecting angles, not or ± differentiated at the basal angles. Dioicous; perichaetia lateral; perichaetial leaves erect or sheathing at base, long-acuminate, the subulae usually wide-spreading. Setae elongate, smooth; capsules horizontal to pendulous (or rarely erect), oblong-ovoid to oblong-cylindric, mostly asymmetric; annulus generally present; operculum conic or convex, acute, mammillate, or shortly and obliquely rostrate; stomata in the neck; peristome teeth lance-subulate, cross-striolate and bordered below, papillose above, trabeculate; endostome with a high basal membrane, keeled and perforate or gaping segments, and often nodose or appendiculate cilia in 2's and 4's. Spores spherical. Calyptrae cucullate, smooth, naked.

Paraphyllia none or very few and restricted to the branch bases; stem and branch leaves not much differentiated — 1. *Rhytidiadelphus*

Paraphyllia very abundant, on stems and branches; stem and branch leaves differentiated — 2. *Hylocomium*

## 1. **Rhytidiadelphus** (Lindb. *ex* Limpr.) Warnst.

Rather coarse and robust plants in loose, green or yellowish, dull or ± shiny mats or tufts. Stems decumbent or erect-ascending, sparsely branched to subpinnate or closely branched in various directions; branches short and blunt or long and tapering, often decurved and sometimes radiculose at the tips; paraphyllia and pseudoparaphyllia none. Stem and branch leaves similar, crowded, erect and oblong-ovate or cordate at the base and gradually or abruptly acuminate, generally squarrose, squarrose-recurved, or falcate-secund at the acumen, mostly ± striate or plicate; margins plane, serrulate to serrate; costa double, short or fairly long and reaching the leaf middle or more, or sometimes lacking; cells linear, smooth or spinose-papillose at back because of projecting angles, broader and shorter below, ± incrassate, porose, and colored at the insertion, not or somewhat differentiated at the basal angles. Perichaetial leaves with squarrose-recurved subulae. Capsules horizontal, oblong-ovoid, short-necked, asymmetric, somewhat furrowed when dry; annulus of 2-3 rows of cells; operculum conic and apiculate; cilia of endostome nodulose, in groups of 1-3.—Although the name has been interpreted as meaning twin wrinkles, it was intended to refer to a brotherly relationship to the genus *Rhytidium* (which has wrinkled or undulate leaves).

Leaves gradually tapered to a broad, flat, erect- to wide-spreading acumen, irregularly plicate; leaf cells dentate-papillose at back — 1. *R. triquetrus*
Leaves rather abruptly narrowed to a slender, channeled, squarrose or squarrose-recurved acumen, not plicate; cells smooth — 2. *R. squarrosus*

1. **Rhytidiadelphus triquetrus** (Hedw.) Warnst.—Plants dark- to bright- or yellow-green. Stems decumbent or erect, up to 20 cm. long, irregularly and unequally branched to closely and equally branched on all sides; stems and branches orange-red; branches horizontal, mostly tapered and decurved at the tips. Stem leaves erect- to wide-spreading from a clasping base wet or dry, 3.5-5 mm. long, ovate-cordate, broadly acuminate, irregularly plicate; margins densely serrate in the upper half, rather remotely serrulate nearly to the base; costae slender, nearly parallel, extending about 2/3 the leaf length; upper cells oblong-linear to linear, thin- or rather firm-walled, ± porose, coarsely dentate-papillose at back because of projecting cell ends (and sometimes also rather finely papillose here and there on the upper surface because of similar projections); cells at insertion thick-walled, porose and yellow, the alar cells scarcely differentiated. Branch leaves erect or erect-spreading from a clasping base, 1.5-3 mm. long (or sometimes more), oblong-ovate and acuminate, usually distantly serrulate all around but sometimes densely serrate near the apex. Setae 15-45 mm. long; capsules 1.5-3 mm. long, red-brown; cilia of endostome in groups of 1 or 2. Spores 20-24 $\mu$, faintly papillose to nearly smooth.—n = 5, 6, 10.

Grout, Mosses with Hand-lens and Microscope, fig. 141 (as *Hylocomium*), Moss Flora of North America 3: Pl. 30B. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 43, (ed. 2) Pl. 47.—**Fig. 959-961.**

On soil, humus, and logs in dry or moist forests. Circumpolar; Alaska to Labrador, south to California, Montana, Arkansas, and Florida.

CHEBOYGAN CO.—Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Grass Bay. EMMET CO.—Levering, Pleasantview Swamp, Maple River, Cecil Bay, Big Stone Bay, Conway Bog. MACKINAC CO.—Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Bush Bay, Prentiss Bay, Cut River, Epoufette, Ozark, Caffey Corner. PRESQUE ISLE CO.—Mast Point, Lamprey Experiment Station, Clinton Lake.

A coarse, shaggy moss in loose tufts in coniferous woods, *R. triquetrus* has branches wide-spreading and somewhat 3-ranked. The leaves are crowded and both

*Rhytidiadelphus triquetrus.* 959. Habit. 960. Leaf. 961. Upper cells of leaf.

plicate and rugose. The orange leaf insertion, strong, double costa, and leaf cells stoutly papillose at the ends at back are distinctive features helpful in identification. The common name of SHAGGY MOSS seems appropriate, as does ROUGH NECK MOSS, in reference to a coarse and loutish appearance. (I like less Nina Marshall's invention, TRIANGULAR WOODREVELER!)

2. **Rhytidiadelphus squarrosus** (Hedw.) Warnst.—Plants bright- or yellow-green, somewhat shiny (often grayish-green when dry), up to 15 cm. high. Stems decumbent or loosely ascending, remotely and irregularly to subpinnately branched; stems and branches orange-red; paraphyllia none. Stem leaves usually not particularly crowded, 2.5-3.2 mm. long, cordate-ovate, rounded to the insertion, and strongly sheathing at base, rather abruptly narrowed to a long, slender, channeled, squarrose or squarrose-recurved acumen, not plicate; margins serrulate at the tip and indistinctly sinuate-serrulate to the middle or more; costae ending about ¼ up the leaf; cells linear, smooth at back; alar cells somewhat enlarged, pale, and oblong in fairly well-marked groups. Branch leaves somewhat smaller, usually more crowded and less strongly spreading. Setae 17-33 mm. long; capsules 1.8-2.5 mm. long; cilia in 3's. Spores 11-17 $\mu$, very finely papillose.—n = 6-8 (as estimated by Heitz), 10.

Conard, How to Know the Mosses, (ed. 2) fig. 289. Darlington, Mosses of Michigan, fig. 141. Grout, Mosses with Hand-lens and Microscope, fig. 142.—**Fig. 966-967.**

Very rare in our area. On soil, humus, logs, or rocks in wet, shady places. Europe and Asia; Alaska to Oregon and Montana; Greenland; Newfoundland to Michigan and Tennessee.

CHEBOYGAN CO.—Reeses Bog and "Douglas Lake."

Known by its pale color, rather tall and sparsely branched stems, and squarrose-recurved stem leaves.

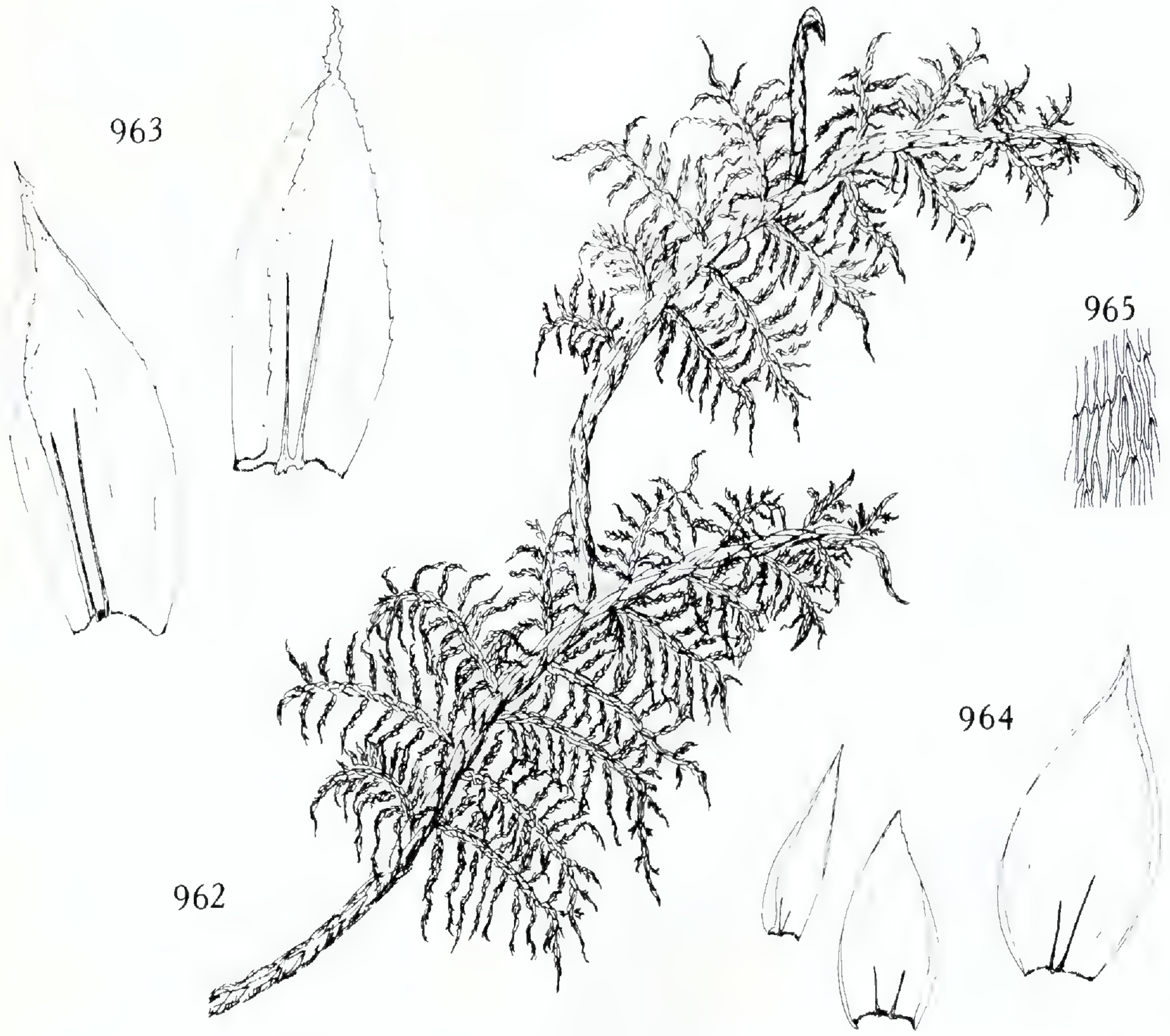
**Rhytidiadelphus loreus** (Hedw.) Warnst. is similar to *R. squarrosus.* It has leaves irregularly plicate and alar cells scarcely differentiated. Occurring in the East and also in the West, it may occur as a disjunct in the Lake Superior region.

## 2. **Hylocomium** BSG

Fairly robust plants in loose, yellow or olive-green, dull or shiny mats or tufts. Stems spreading or ascending, arcuate, irregularly pinnate to regularly 2- to 3-pinnate and frondose from a stipitate base, sometimes layered because of repeated annual growth from arched-ascending, stoloniform innovations; paraphyllia abundant, filiform, branched. Stem and branch leaves differentiated: Stem leaves loosely erect or erect-spreading, irregularly plicate, broadly oblong-ovate and rather abruptly narrowed to a short or long, often ± rugose acumen; margins plane or reflexed at base, serrate or serrulate all around; costa double, short or sometimes reaching the leaf middle, or single; cells linear, smooth or spiculose here and there at back because of projecting ends, oblong, incrassate, porose, and yellowish at the insertion, not differentiated at the basal angles. Perichaetial leaves usually squarrose-recurved at the tips. Capsules horizontal or nearly so, oblong-ovoid, short-necked, asymmetric; annulus usually present, of 2 rows of cells; operculum conic and apiculate or stoutly rostrate from a convex base; cilia of endostome 2-4, rarely 1-2, nodulose.—The name means woods-inhabiting.

Stem regularly 2-3-pinnate and frondose in a layered arrangement resulting from successive years' growth from a curved-ascending stoloniform innovation; costa double; branch leaves not twisted at the apex ..... 1. *H. splendens*
Stem irregularly pinnate, not layered or innovating from a stoloniform shoot; costa single; branch leaves mostly twisted at the apex ..... 2. *H. pyrenaicum*

1. **Hylocomium splendens** (Hedw.) BSG—Plants in dull, green or yellowish mats. Stems stiff and wiry, regularly 2-3-pinnate in horizontal fronds in a step-wise




*Hylocomium splendens.* 962. Habit. 963. Stem leaves. 964. Branch leaves. 965. Cells from upper part of branch leaves.

arrangement, each frond produced by an arched and ascending, stoloniform innovation arising from the middle of the previous year's growth; stems and branches reddish. Stem leaves loosely erect, 2-3 mm. long, lightly plicate, broadly oblong-ovate, abruptly narrowed to short or long, often rugose acumen; margins recurved below, serrulate above, ± inflexed at the base of the acumen; costa double, less than 1/3 to nearly 1/2 the leaf length; upper cells linear-flexuose, spiculose-papillose here and there at back because of projecting upper angles. Leaves of primary branches 1.2-1.5 mm. long, oblong-ovate, acute or acuminate. Leaves of branchlets 0.4-0.8 mm. long, oblong-lanceolate, sharply or bluntly acute, with margins incurved above, serrulate in the upper half, often sinuate-serrulate nearly to the base. Setae 12-30 mm. long, orange-brown or reddish, ± flexuose; capsules 1.5-2.7 mm. long, brown, somewhat constricted below the mouth when dry; operculum stoutly and obliquely rostrate, 1.6-2 mm. long. Spores 13-18 $\mu$, very finely papillose.—n = 10, 10+2, 11, 12.

Conard, How to Know the Mosses, (ed. 2) fig. 172. Darlington, Mosses of Michigan, fig. 140. Grout, Mosses with Hand-lens and Microscope, fig. 140 (as *H. proliferum*), Moss Flora of North America 3: Pl. 31 above. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 43, (ed. 2) Pl. 47.—**Fig. 962-965.**

On humus, soil, and rocks in moist or wet forests, especially in deeply shaded ravines, occasionally also on rotten logs or bases of trees. Circumpolar; reported from New Zealand; in North America south to Oregon, Colorado, Iowa, and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Grass Bay. EMMET CO.–Pleasantview Swamp, Five Mile Creek, Wycamp Lake, Cecil Bay, Big Stone Creek, Conway Bog. MACKINAC CO.–Mackinac Island, St. Martins Point, McKays Creek, Prentiss Bay, Hog Island Point, Cut River, Epoufette, Ozark. PRESQUE ISLE CO.–Presque Isle Lighthouse, Evergreen Beach, Hammond Bay, Mast Point, Clinton Lake.

*Hylocomium splendens* is attractive and, indeed, splendid. It is sometimes called the MOUNTAIN FERN MOSS because of a resemblance to *Thuidium delicatulum*, the Fern Moss. I like the name STAIR-STEP MOSS because the branching is neatly 2-3-pinnate in successive sprays corresponding to annual layers of growth. (Poorly developed plants may be confused with *Pleurozium schreberi*, but the absence of paraphyllia in *Pleurozium* is a decisive difference.)

2. **Hylocomium pyrenaicum** (Spruce) Lindb.–Plants rather robust, in light- or yellow-green to yellow-brown, moderately shiny mats. Stems ascending, remotely and irregularly pinnate, not stipitate or layered, without stoloniform innovations; branches often cuspidate-tipped. Stem leaves loosely erect or erect-spreading when dry, erect-spreading when moist, 2.2-2.5 mm. long, broadly oblong-ovate, gradually or abruptly acuminate, narrowed to a non-decurrent base, irregularly plicate; margins ± revolute below (especially when dry), spinulose-serrate in the upper 1/3-1/2; costa single, ending 2/3-3/4 up the leaf, usually in a dorsal spine; cells oblong-linear, flexuose, with thin or rather firm walls, smooth at back. Branch leaves somewhat differentiated, 1.5-2.5 mm. long, broadly oblong-ovate and abruptly short-acuminate to oblong-lanceolate and more gradually acuminate, with mostly twisted apices. Setae slender, flexuose, reddish, 10-22 mm. long; capsules red-brown, shortly ovoid-cylindric, 1-1.8 mm. long; annulus none; operculum conic, bluntly apiculate, 1 mm. long; cilia in 2's or occasionally single. Spores 15-20 $\mu$, very finely papillose.–n = 9, 11+1, 12.

Grout, Moss Flora of North America 3: Pl. 31B.–**Fig. 968-969.**

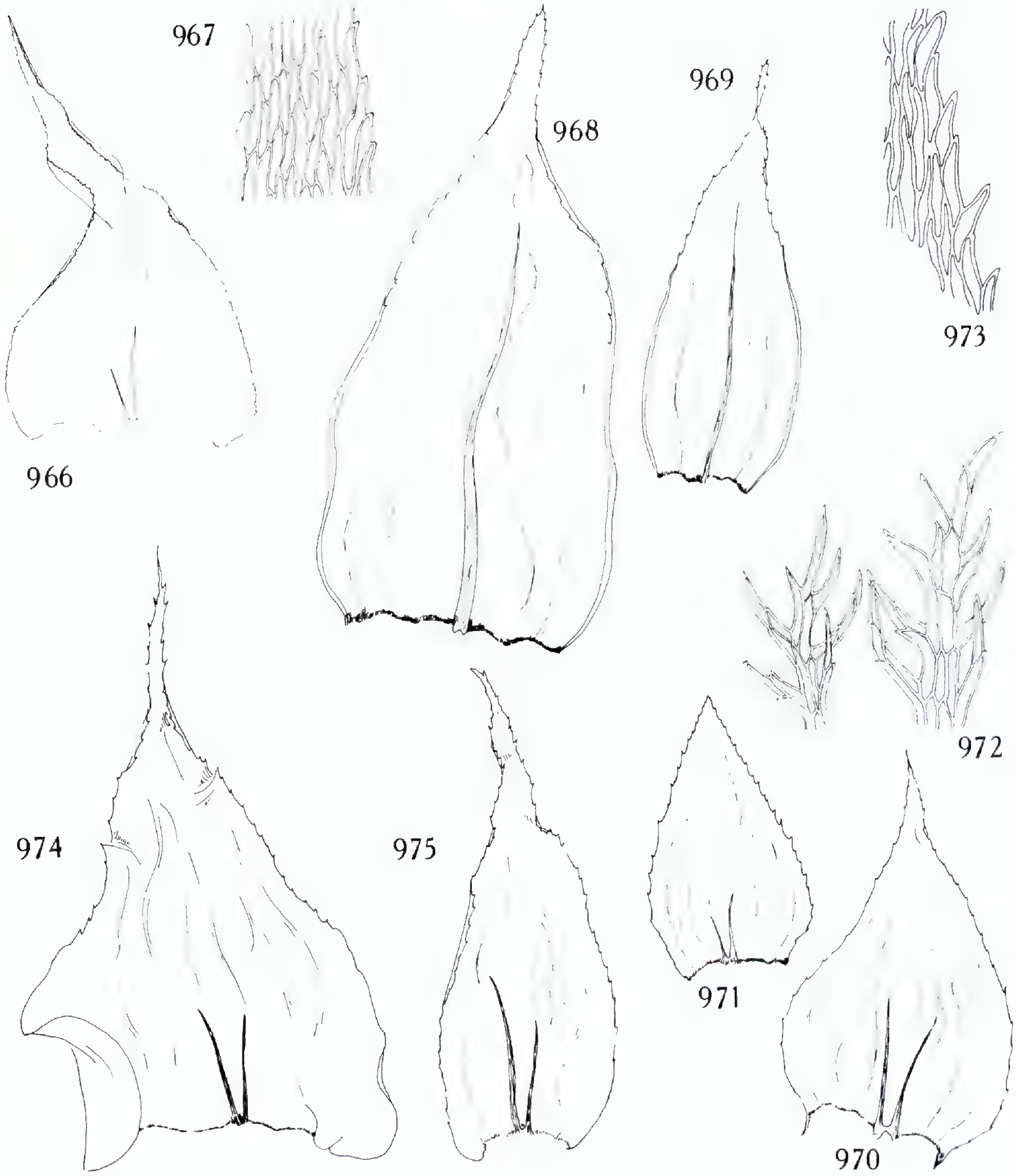
On logs, humus, or rocks in woods. Europe and Asia; Alaska and the Aleutians, British Columbia and Colorado; Newfoundland to New York and Michigan.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge (Carp Creek), Little Lake 16.

Only indistinctly pinnate and not forming layered innovations, the plants have rather stout, tumid branches tapered to the ends and in the field resemble a *Brachythecium*.

**Hylocomium umbratum** (Hedw.) BSG (fig. 970-973) occurs not too far from the Straits, at the Lower Falls of the Tahquamenon River (Chippewa County). The plants are relatively slender. They branch in a bushy fashion from an inconspicuous stipe and do not form flat fronds corresponding to the growth of successive years (as in *H. splendens*). The stem leaves are decurrent, spinulose-serrate all around, and bicostate 1/2-2/3 their lengths. The leaf cells are smooth. (The chromosome number is recorded as n = 6+1, 7.)

Not yet found in Michigan though widely distributed from Ontario and Ohio eastward and southward is **Hylocomium brevirostre** (Brid.) BSG (fig. 974-975). It has abundant paraphyllia, allying it to *Hylocomium*, and yet its aspect is something like that of *Rhytidiadelphus loreus* or *R. squarrosus*. The plants do not form flat fronds, the costa is double, and the leaf cells are smooth. It differs from *H. umbratum* in being larger and coarser and having leaves of stipes and innovations with squarrose tips, and its stem leaves are pinched and rugose at the base of the acumen, serrate in the upper half or more, serrulate below, and not decurrent.




*Rhytidiadelphus squarrosus.* 966. Leaf. 967. Upper cells of leaf.
*Hylocomium pyrenaicum.* 968. Stem leaf. 969. Branch leaf.
*Hylocomium umbratum.* 970. Stem leaf. 971. Branch leaf. 972. Parpahyllia. 973. Cells at margin of upper part of branch leaf.
*Hylocomium brevirostre.* 974. Stem leaf. 975. Branch leaf.

**Rhytidium rugosum** (Sull.) Kindb., which occurs in the Upper Peninsula, is an attractive golden-brown moss, erect-ascending and often regularly pinnate, with leaves falcate-secund and both plicate and rugose. The costa is single. It grows on rocky soil in dry, exposed places and is most often associated with limestone.

## BUXBAUMIACEAE

Small, annual plants, scattered or gregarious, growing from a ± persistent protonema. Stems very short, simple. Leaves few, very small, broadly ovate or

ovate-lanceolate, green at base, hyaline above, ciliate-margined, ecostate; cells laxly oblong-hexagonal, the marginal cilia continuing growth to form a tomentum over the stem and the base of the seta. Dioicous; male plants minute, consisting of a single bract resembling a clam shell and enclosing a single antheridium on a cygneous stalk, resting on the protonema; female plants producing terminally usually 1 archegonium and no paraphyses, the perichaetial leaves not differentiated. Setae elongate, stout and rigid, reddish, warty-papillose; capsules oblique to horizontal from a short, stout, erect neck, ovate or narrowly oblong-ovate, narrow at the mouth, flat or concave on the upper side, swollen on the lower, the upper and lower surfaces sometimes separated by a distinct or indistinct rim; annulus none, dehiscence aided by a mass of enlarged, ovoid or globose cells between the epidermis and the peristome; operculum bluntly conic, falling with the top of the columella; stomata at junction of neck and seta, superficial or immersed; exostome consisting of 1-4 concentric series of irregular and sometimes rudimentary, smooth or papillose teeth, sometimes partially joined as a membrane, increasing in size toward the endostome; endostome a pale, 16-plicate membrane forming a truncate cone (open at the apex). Spores spherical. Calyptrae shorter than the operculum, cucullate, conic or thimble-shaped, naked.—The family consists of a single genus, *Buxbaumia* Hedw. Johann Christian Buxbaum, a German physician-botanist, discovered the genus in 1712 near the mouth of the Volga River and described it in 1728, without giving it a name. He wished to follow the example of Marchant and make it into a new genus named for his father but called to mind the fox who was derided because he begged grapes, not for himself, but for his sick mother. Haller in 1744 named the genus for the modest Buxbaum. (Fabricius re-christened the genus *Hippopodium* in reference to the horseshoe-shaped ridge around the capsule of *B. aphylla,* and Palisot de Beauvois called it *Saccophorus* because of the belly-like swelling at the base of the capsule.)

**Buxbaumia aphylla** Hedw.—Setae erect or nearly so, about 4-11 mm. long, capsules strongly inclined to nearly horizontal from a stout, erect neck, chestnut-brown, broadly ovoid, 3-5 mm. long, nearly as broad as long, flattened on the upper side, angled between the upper and lower surfaces, the epidermis peeling back a short distance from the mouth after dehiscence; operculum about 1 mm. long; stomata immersed, consisting of 2 guard cells or a single rounded cell with a central pore; exostome relatively well developed, consisting of a single, brown, smooth membrane dissected at the apex into 16 short, unequal teeth; endostome well developed, pale-tawny, papillose. Spores smooth, 6.5-8 $\mu$.—n = 8; 2n = 16.

Conard, How to Know the Mosses, (ed. 2) fig. 30a. Darlington, Mosses of Michigan, fig. 143. Grout, Mosses with Hand-lens and Microscope, fig. 19 & Pl. 8 left, Moss Flora of North America 1: Pl. 73A (fig. a). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 26, (ed. 2) Pl. 30. Welch, Mosses of Indiana, fig. 63.—**Fig. 976.**

A pioneer of disturbed, sandy or clayey soil, sometimes on logs or stumps, in partial shade in moist forests and also in dry, open woods, frequently on banks of trails or roads; locally common on sandy soil and old wood in aspen stands (successional to fire). Europe and Asia; Greenland; Yukon to Colorado; Michigan to Nova Scotia, south to Delaware.

CHEBOYGAN CO.—Above the Gorge of Carp Creek, Iron Bridge, Hogback Road, Biological Station campus, near Bryants Bog, Grapevine Point, Colonial Point, Mud Lake, Little Lake 16. EMMET CO.—Pellston Hills, Cecil Bay, Wilderness State Park. MACKINAC CO.—Ozark. PRESQUE ISLE CO.—Huron Beach, Evergreen Beach.

"This is as strange a thing as e'er I looked on,
As disproportionate in manners as in shape."

It was Elizabeth G. Britton, who thus quoted Shakespeare to describe these HUMP-BACKED ELVES (The Observer 7: 105-113. 1896). Dillenius, some 200 years

ago, referred to *Buxbaumia aphylla* as the queen of mosses, and Grout called it a BUG-ON-A-STICK. The capsule (which might be described as elegantly tear-shaped) is as large as that of a *Polytrichum* and quite oversized in proportion to the seta and the extremely reduced gametophyte.

It is said that the great W. J. Hooker became interested in mosses as a result of discovering a colony of this curious moss. Braithwaite said, "This strange plant has the annoying habit of disappearing from the stations it occupies, probably due to some change in the constituents of the substratum on which it is produced, and thus we can never rely upon finding it a second time in the same locality." The reason for its ephemeral character has to do with a pioneer role in succession. Occupying barren, disturbed habitats, it is quickly crowded out by larger, more vigorous competitors. However, it has been produced in abundance year after year on dry, sandy soil and old wood in the aspens near the entrance to the Biological Station, where succession has been kept at a standstill by inhospitable edaphic conditions. (From my own memory, I can say that it was there in 1958 and every year from 1965 through 1973.) It is easily spotted by a blackish alga-like crust which may be partly protonema but almost invariably includes a growth of a minute leafy liverwort (*Cephaloziella*). It grows in burned-over areas not yet occupied by an understory of *Pteridium,* in open *Cladonia* barrens where soils are virtually lacking in humus, except for occasional bits of wood. The *Cladonia* barrens, occupied especially by reindeer lichens, mark places of excessive burning. It was common practice to cut the pines once abundant in the area in such a way that their crowns fell together for convenience in trimming, thus leaving great slash piles which burned more intensely than surrounding areas.

Uggla (Acta Phytogeogr. Suec. 41: 94. 1958), studying the effects of fire in northern Scandinavia, found *Buxbaumia aphylla* in 1947 on sites burned in 1933 and fully exposed to the sun. He was unable to locate the species in 1949, 1953, or 1957 or find it on sites burned in 1920 or 1941 and concluded that sporophytes were produced only at a certain stage in the succession following fire. (Uggla's findings on *Buxbaumia* are summarized by Jones, Trans. Brit. Bryol. Soc. 6(1): 56-68. 1970.) Locally, in Michigan, the calendar of events has been quite different. According to Kilburn (Papers Mich. Acad. Sci., Arts & Lett. 45: 77-81. 1960), the best quality of pine and hemlock were removed from Station property between 1870 and 1880. Poor quality conifers were cut between 1880 and 1900 and hardwoods from 1900 to 1920. For 40 years after the original cutting was completed, in 1880, fires occurred here and there almost constantly, with major burns in 1892, 1901, 1911, and 1923. An area along the power strip north of Reeses Bog and east of Carp Creek, more or less the area where *Buxbaumia* is now so abundant, was burned in 1880, 1890, 1896, 1899, and 1907. It presumably escaped the fires of 1901, 1911 and 1923 which damaged nearby areas closer to Douglas Lake (according to unpublished information given me by Edward Voss). Thus the area has apparently been available to *Buxbaumia* at least since 1923 (50 years) and probably since 1907 (66 years).

*Buxbaumia* is often associated with old logs or bits of wood humus. It has been considered saprophytic in nutrition more because of morphological reduction than any physiological evidence. Haberlandt (Jahrb. Wiss. Bot. 17: 359-598. 1866) considered the extreme reduction of the gametophyte an evolutionary response to saprophytism. He considered the rhizoids similar to the hyphae of fungi in form and probably also in function and thought that the protonema could support the small and evanescent leafy gametophyte but not the large sporophyte. Actually the sporophyte has abundant chlorophyll until a late stage of maturity and looks to be capable of self-support. It has been demonstrated in other mosses that the sporophyte is nutritionally independent (Bold, Amer. Jour. Bot. 27: 318-322. 1940; Rastorfer, Phyton 19: 169-177. 1962; Wolf, Nature 181: 579-580. 1958).

It is interesting to note that Buxbaum, 250 years ago, considered *B. aphylla* a

moss, while noting its fungus-like appearance, although Haller, Dillenius, and other early authors indeed considered it a fungus!

Capsules are held aloft in a torch-like manner when young but later become tilted owing to the influence of light on the distribution of auxin. Evidence of such phototropism was provided by a study in the open aspen stands at Douglas Lake, where it was found that the pointed ends of capsules are generally directed toward the greatest incidence of light, 45% to the southwest and 30% to the south (Taylor, Mich. Bot. 11: 70-73. 1972). *Diphyscium foliosum,* so similar in capsule form, shows a similar orientation toward the light source. Phototropism has been investigated in the setae of *Splachnum*; see Walsh, Naturalist, no. 823: 137-139. 1947.

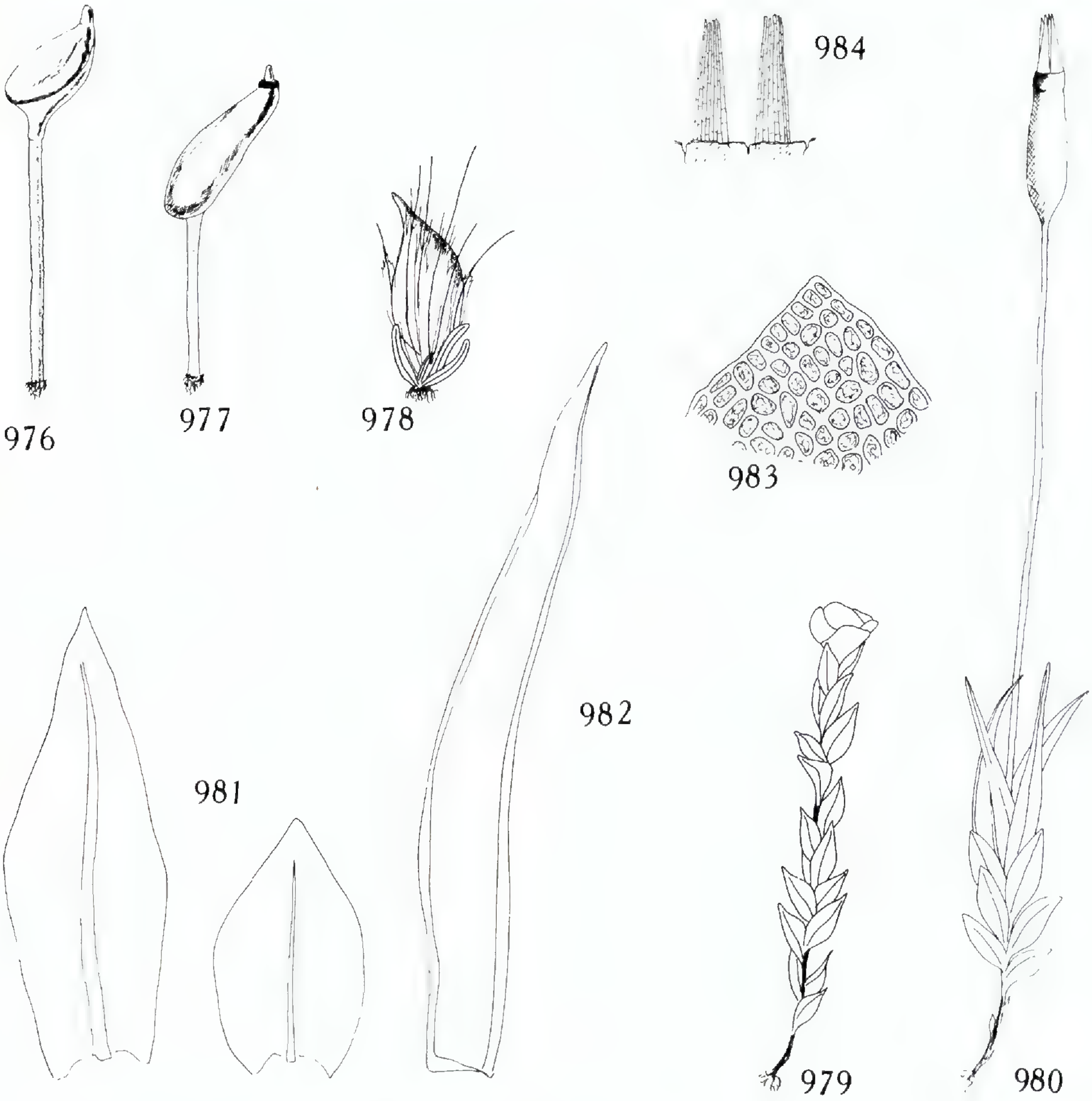
An interesting feature of *Buxbaumia* is its sexual dimorphism.

**Buxbaumia minakatae** Okam. (*B. subcylindrica* Grout)—fig. 977—should be sought on rotten logs and stumps in lowland woods, in such places as *Tetraphis* and *Lophocolea* grow. It has setae only 3-5 mm. long, capsules only slightly inclined, lance-cylindric, not flattened dorsally or angled between the upper and lower surfaces. It has been found near Galesburg in southern Michigan.

## DIPHYSCIACEAE

Small perennials in dense sods, dull, dark-green, becoming brown or blackish with age. Protonema persistent, bearing peltate appendages. Stems mostly very short, erect, usually simple. Lower leaves small, crowded, crisped and sometimes inrolled when dry, ± spreading when moist, lingulate or lingulate-subulate, rounded-obtuse to acute, mostly entire; costa single, strong, ending below the apex or filling it; upper cells 2-3-stratose from the costa nearly to the margins, obscure, rounded-quadrate or rounded-hexagonal, often oblate, incrassate, plane or mammillose on both surfaces; basal cells unistratose, pale, smooth, rectangular or oblong-hexagonal. Upper and perichaetial leaves longer, erect, scarious, ovate-lanceolate, lance-subulate, or linear, generally fringed at the apex and awned by the excurrent costa. Setae terminal, very short; capsules immersed, obliquely ovoid-conic, very narrow at the mouth, rounded at the base and swollen on 1 side, thin-walled, not angled or differentiated in color between the upper and lower surfaces; annulus present; operculum conic, acute; peristome teeth 16, very short and irregular, ± separate; endostome a conspicuous, whitish, membranous, densely papillose, open cone with 16 keels projecting between the teeth. Calyptrae scarcely covering the operculum, conic or thimble-shaped, smooth and naked.—Represented in our area only by **Diphyscium** Mohr, named because the capsule wall is fairly distinct from the spore sac, being connected with it by short filaments, resulting in a double "bladder." (There is no really good reason to separate the Diphysciaceae from the Buxbaumiaceae, other than tradition.)

**Diphyscium foliosum** (Hedw.) Mohr—Small plants in rigid, dark-green or more often brown to blackish, extensive tufts. Stems very short. Leaves strongly curled and contorted when dry, erect-spreading when moist, 1.3-4 mm. long (becoming longer toward the stem tips), broadly ligulate or lingulate, obtuse or rounded-obtuse and usually ± cucullate at the apex; margins erect, crenate above the base; costa vanishing near the apex; upper cells 6.5-7.5 $\mu$ wide, irregularly rounded and often somewhat oblate, incrassate, mammillose-bulging on both surfaces. Dioicous; perichaetial leaves up to 8 mm. long, with costa long-excurrent as a brown, spinulose awn and cells delicate with notably thickened cross-walls. Capsules nearly sessile, greenish-yellow, becoming brown, about 3 mm. long; annulus well developed; operculum 1.1-2 mm. long; stomata numerous, at base of urn; peristome teeth very short and irregular (usually difficult to




*Buxbaumia aphylla.* 976. Habit (sporophyte).
*Buxbaumia minakatae.* 977. Habit (sporophyte).
*Diphyscium foliosum.* 978. Habit.
*Tetraphis pellucida.* 979. Habit of sterile plant. 980. Habit of fruiting plant. 981. Leaves. 982. Perichaetial leaf. 983. Cells at leaf apex. 984. Portion of peristome.

discern, although the whitish endostome is conspicuous). Spores 9-10 $\mu$, finely papillose. Calyptrae conic, acute.–n = 8, 9, 10; 2n = 16.

Conard, How to Know the Mosses, (ed. 2) fig. 30b-d. Darlington, Mosses of Michigan, fig. 144. Grout, Mosses with Hand-lens and Microscope, fig. 20 (as *Webera sessilis*), Pl. 8 right. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 25, (ed. 2) Pl. 29. Welch, Mosses of Indiana, fig. 64.–**Fig. 978.**

In moist hardwood forests, on soil or humus of shaded banks in late stages of moss-lichen succession, sometimes on rock walls of stream gorges. Europe and Madeira; Japan; widespread in eastern North America; Mexico, Guatemala, and Jamaica.

CHEBOYGAN CO.–Near Bryants Bog, Colonial Point, Munro Township, Mullett Lake. EMMET CO.–Pellston Hills, Middle Village Road east of Good Hart, Cross Village. MACKINAC CO.–Mackinac Island.

The broad, sloping upper surface of the capsules apparently serve a purpose in spore dispersal. According to Goebel, pelting rain drops cause spores to be emitted in

little puffs to a distance of two inches. (*Diphyscium foliosum* has been called the POWDER GUN MOSS.) As in *Buxbaumia,* the capsules are directed toward the light, but the adaptive significance of this is lost on me.

William C. Steere has said that *Diphyscium* looks like scared rabbits in the grass. It may be recognized when sterile by broadly ligulate, blunt leaves consisting of several layers of cells, those at the upper and lower surfaces conspicuously bulging. When dry the leaves are dark and crisped, looking like they were dipped in hot butter (a happy comparison supplied, again, by Dr. Steere).

## TETRAPHIDACEAE

Plants small and tufted or minute and scattered to gregarious. Stems erect, mostly simple. Leaves erect-spreading in 3 ranks (sometimes obviously so), scarcely altered on drying, ovate to oblong-lanceolate or lance-acuminate, acute, not bordered; costa single, weak and sometimes absent or well-developed and ending well below the apex to subpercurrent; upper cells irregularly rounded-hexagonal or oblong-rhomboidal, smooth; lower cells elongate. Autoicous. Setae terminal, elongate; capsules cylindric or ovoid-cylindric, erect and symmetric or somewhat curved, smooth; annulus none; operculum conic or conic-apiculate; peristome single, the 4 teeth inserted below the mouth, narrowly triangular (actually pyramidal, representing the entire tissue within the operculum and consisting of whole cells elongated lengthwise of the teeth), yellow-brown, smooth. Spores spherical. Calyptrae narrowly mitrate, plicate, naked.—A curious feature of this family of two small genera is the presence of "frondiform leaves" which appear on the protonema at the first development of the stem. They are more or less ligulate to spatulate. In *Tetradontium brownianum,* they are often forked. In that species they are abundant and persistent. In *T. pellucida,* they disappear early and are rarely seen, although they can be found easily on rotten wood where *Tetraphis* abounds. (A more suitable name than "frondiform leaves" might be protonematal flaps.)

### **Tetraphis** Hedw.

Rather small plants in dense, dull, green or red-brown tufts. Stems erect-flexuose, naked below, rather densely foliate above, radiculose only at base, simple or, if bearing perigonia, sometimes forked; sterile stems frequently ending in a rosulate cluster of stalked, discoid brood-bodies surrounded by rounded bracts of varying size. Leaves ± keeled and somewhat tristichous, somewhat decurrent, the lower leaves ovate and acute, the upper and perichaetial leaves gradually longer and narrower, lanceolate and gradually acuminate; margins entire, plane or broadly reflexed; costa ending well below the apex in lower leaves, subpercurrent in upper and perichaetial leaves; cells irregularly rounded-hexagonal and thick-walled above, oblong near the insertion, or in upper leaves oblong-linear in most of the base. Perigonia at the ends of innovations from the base of sterile plants or on separate, simple or forked male shoots freely mingled with the others, with abundant paraphyses. Capsules erect and symmetric or slightly curved, cylindric, red or brown at the mouth; operculum conic; exothecial cells elongate below, small and thicker-walled in several suboral rows; stomata none; peristome teeth narrowly long-triangular. Calyptrae whitish below, sometimes slightly roughened near the apex.—The name means bearing or producing four, referring to the four peristome teeth. This name was used by Hedwig in 1801 and has legal priority over *Georgia,* which Ehrhart dedicated to his patron George III of England, who was also Elector of Hannover.

**Tetraphis pellucida** Hedw.–Plants about 8-15 mm. high. Leaves plane and entire at the margins (or broadly reflexed, at least when attached to the stems), lower leaves about 1-2 mm. long, the upper and perichaetial leaves up to 3 mm. long; upper cells about 13-20 $\mu$. Setae 6-14 mm. long, twisted when dry, erect or ± flexuose, smooth; capsules 2-3 mm. long; operculum about 1 mm. long; peristome teeth about 0.5-0.9 mm. long. Spores 10-13 $\mu$, nearly smooth or finely roughened.–n = 7, 8; 2n = 14.

Conard, How to Know the Mosses, (ed. 2) fig. 51. Darlington, Mosses of Michigan, fig. 26. Grout, Mosses with Hand-lens and Microscope, fig. 13 (as *Georgia*), Moss Flora of North America 1: Pl. 3 right. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 26, (ed. 2) Pl. 30. Welch, Mosses of Indiana, fig. 20.–**Fig. 979-984.**

Typically on very rotten stumps or logs, sometimes on wood humus, rarely on soil or rock. Circumpolar; Labrador to Alaska, south to California, Arizona, Colorado, Arkansas, and South Carolina.

CHEBOYGAN CO.–Reeses Bog, Hermits Bog, Gorge of Carp Creek, Iron Bridge, Colonial Point, Gleasons Bog, Wolffs Bog, Livingston Bog, Mud Lake, Grass Bay, Weber Lake. EMMET CO.–Pleasantview Swamp, Pellston Hills, Levering, Galloway Bog, Carp Lake, Stutsmanville, Wycamp Lake, Cross Village, Cecil Bay, Conway Bog. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Prentiss Bay, Cut River, Epoufette, Ozark, Hendricks, McNamara Pond. PRESQUE ISLE CO.–Lamprey Experiment Station, Evergreen Beach, Clinton Lake, Loon Lake, Rainy Lake.

The gemmae cups suggest those of *Marchantia polymorpha.* Dispersal by rain drops falling on such splash-cup structures has been investigated by Brodie (Canad. Jour. Bot. 29: 224-234. 1951; Proc. Indiana Acad. Sci. 66: 65-73. 1957). In related investigations, Brodie and Gregory (Canad. Jour. Bot. 31: 402-410. 1953) showed that spores and other reproductive bodies may be more readily blown from cupulate structures (especially in some species of *Cladonia*) than from flat surfaces, owing to a vortex of turbulence which sucks out spores and lifts them above the relatively still air near the surface into the main airflow.

**Tetraphis geniculata** Girg. *ex* Milde has setae abruptly bent midway (like a knee) and rough above the bend. It occurs in the East and also in the West and should be looked for as a disjunct in the Lake Superior region.

Also, in Michigan's Upper Peninsula we have **Tetradontium brownianum** (Dicks.) Schwaegr., a rare moss of dark recesses, such as crevices of cliffs or undersides of siliceous or granitic ledges. The minute and bud-like plants are gregarious but not caespitose. The protonematal flaps are forked (and they are numerous and persistent). The costa is weak, ending well below the apex of the leaf or sometimes lacking. The upper cells are oblong-rhomboidal, the capsules oblong-ovoid, and the operculum obliquely apiculate.

## POLYTRICHACEAE

Plants mostly robust and rigid, usually tufted (rarely scattered or gregarious and growing from a persistent protonema). Stems erect, sometimes from a ± decumbent base, usually simple. Lower leaves small, appressed, remote and sometimes scale-like, the upper larger and more crowded, generally differentiated into a pale, broad, sheathing base and a narrow, ± spreading limb which is often bistratose nearly to the margins, with long, green lamellae on the upper side of the costa and often covering most of the lamina as well (sometimes lamellose on the lower side of the leaf also);

margins mostly strongly toothed, sometimes bordered by elongate cells; costa single, strong, ending near the apex to excurrent; upper cells isodiametric, smooth or rarely ± papillose (the cuticle often longitudinally striate); cells of leaf base mostly rectangular to linear, narrower toward the margins. Mostly dioicous; perigonia cupulate or discoid, often conspicuously rosulate, often producing an innovating branch from the center, with intermingled claviform and filiform paraphyses; perichaetial leaves not or somewhat differentiated. Setae elongate; capsules erect or nearly so to horizontal, cylindric or 4-6-angled, ± flattened, and prismatic, sometimes clearly differentiated at the neck; annulus none or very narrow; operculum acute to rostrate from a convex-conic base; peristome single, consisting of 32-64 (rarely 16) short, lingulate teeth attached at their tips to a discoid expansion of the tip of the columella, consisting of whole cells which are elongate and fiber-like and follow the contour of the teeth in several concurrent series, mostly pale except for the midline. Spores spherical, smooth. Calyptrae cucullate, sometimes roughened at the tip, rarely naked, usually densely pilose.

The peristome teeth of the Polytrichaceae consist of whole cells which become greatly elongate and compressed. Thus, at maturity, the teeth consist of several layers of fine threads extending from the apex of one tooth through the basal membrane and up again to the apex of the adjacent tooth, those in the middle being even more compressed and forming an apparent median line. The tips of the teeth are attached to the expanded, tympanum-like top of the columella. When dry, the columella is retracted, leaving space between the teeth for spores to be dispersed by a salt-shaker mechanism.

Smith (Mem. N.Y. Bot. Gard. 21(3): 1-83. 1971) presented some refinements on generic concepts in the Polytrichaceae (not followed in the present treatment), together with a wealth of information on peristome structure and vascularization.

Leaves undulate, toothed at back of lamina and costa, bordered, doubly serrate; lamellae restricted to the costa; capsules cylindric, not angled; calyptra naked or sparsely short-bristled at the tip ..... 1. *Atrichum*

Leaves not undulate, ± toothed at back of costa, not bordered, entire or singly serrate; lamellae covering the costa and most of the lamina as well; capsules cubic to prismatic, 4- or sometimes 6-angled; calyptra completely covered by long hairs ..... 2. *Polytrichum*

## 1. **Atrichum** P.-Beauv., *nom. cons.*

Plants medium-sized to fairly robust, in loose, dull, dark-green tufts, becoming brown or red-brown with age. Leaves crisped and contorted when dry, erect or erect-spreading when moist, usually undulate and toothed at back of lamina and costa, lingulate to oblong-lanceolate, acute or sometimes rounded-obtuse, not sheathing at base, nearly flat or somewhat concave or keeled toward the apex, bordered by elongate cells and singly or doubly serrate; costa narrow, ending somewhat below the apex to percurrent, covered on the upper side by rather few, long, usually somewhat wavy, green lamellae with undifferentiated marginal cells; cells unistratose, green throughout, smooth or rarely ± papillose, hexagonal above, short-rectangular below. Perichaetial leaves scarcely differentiated. Setae single or sometimes clustered; capsules cylindric from a short, tapered neck, suberect or somewhat inclined, often somewhat curved, smooth; annulus and stomata none; operculum long-rostrate from a convex or hemispheric base; exothecial cells smooth; peristome teeth 32, pale with a yellow to red-brown mid-line. Calyptrae smooth and naked or sometimes sparsely toothed or bristly at the tip.—The name refers to the absence of hairs on the calpytra, in marked contrast to the usual condition in the family. A more interesting name, earlier but taxonomically unacceptable, *Catharinea,* was provided by Ehrhart in honor of Russia's benevolent despot for reasons that Bridel guessed at in a snide way (*an reverentia? an gratitudine? an benevolentiae captatione?*).

Plants generally 10-20 mm. high; leaves ± concave toward the apex; lamellae ± wavy, 5-14 cells high, obscuring ¼-½ the leaf in the upper third; upper cells 11-19 μ, thick-walled, irregularly isodiametric, only occasionally wider than long 1. *A. angustatum*

Plants typically taller than 20 mm.; leaves ± keeled toward the apex; lamellae straight, 2-5 cells high, obscuring less than ¼ the leaf in the upper third; upper cells 18-30 μ wide, usually rather thin-walled, wider than long 2. *A. undulatum*

1. **Atrichum angustatum** (Brid.) BSG–Plants medium-sized, 10-20 (rarely 45) mm. high. Leaves undulate (especially when dry), toothed at back in oblique rows corresponding to the undulations, 3.5-7, rarely 9 mm. long, oblong-lanceolate or narrowly oblong, acute, ± concave above; margins with mostly double teeth; costa subpercurrent, toothed at back above; lamellae 5-6 (rarely 9), wavy, 5-14 cells high, obscuring ¼-½ the width of the upper 1/3 of the leaf; upper cells 9-19 μ wide, incrassate, irregularly isodiametric, sometimes ± longer than wide, plane or nearly so on the lower surface, bulging on the upper, smooth or ± papillose (sometimes strongly so) on the lower and sometimes also on the upper surface. Dioicous. Setae 10-30 mm. long, occasionally in pairs; capsules 2.7-6.5 mm. long, erect or ± inclined, slightly or rarely strongly curved; operculum 2-3 mm. long; peristome teeth 32. Spores 9-14 μ. Calyptrae ± toothed to short-bristled at the apex.–n = 7, 8.

Breen, Mosses of Florida, Pl. 120. Conard, How to Know the Mosses, (ed. 2) fig. 43. Grout, Mosses with Hand-lens and Microscope, fig. 14c (as *Catharinea*), Moss Flora of North America 1: Pl. 54A-C (including var. *plurilamellatum, A. papillosum, & A. macmillanii*). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 27 (as *Catharinea angustata, C. plurilamellata, & C. papillosa*), (ed. 2) Pl. 31 (as *Atrichum angustatum, A. plurilamellatum, & A. papillosum*). Welch, Mosses of Indiana, Pl. 120.–**Fig. 985-986.**

On light, often sandy soil in dry, open woods and frequently in disturbed places, such as poor lawns, roadbanks, bare mounds in woods. Europe and Asia; Newfoundland to Manitoba and south to the Gulf of Mexico.

CHEBOYGAN CO.–Gorge of Carp Creek, Colonial Point, Grapevine Point, Mud Lake, Little Lake 16. EMMET CO.–Pellston, Pellston Hills, Maple River Township. MACKINAC CO.–Mackinac Island, Gros Cap, Ozark.

2. **Atrichum undulatum** (Hedw.) P.-Beauv.–Relatively robust plants, 1.5-7 cm. high. Leaves undulate (especially when dry), toothed at back in oblique rows corresponding to the undulations, 4.5-9.5 mm. long, oblong-lanceolate or rarely oblong-elliptic, acute, ± keeled at the tip; margins bordered, with mostly double teeth; costa subpercurrent, toothed at back above; lamellae 4-6, nearly straight, 2-5 cells high, obscuring less than 1/4 the width of the upper 1/3 of the leaf; upper cells 18-30 μ wide, hexagonal and ± transversely elongate, not or sometimes incrassate, usually ± thickened at the corners, smooth. Appearing dioicous but occasionally producing antheridia the first year and archegonia the next. Setae 14-40 mm. long, occasionally in 2's, very rarely in 3's; capsules 3.5-6 mm. long, suberect or somewhat inclined, ± curved; operculum 1.5-3 mm. long. Spores 12-16 μ. Calyptrae toothed and short-bristled at the tip.–n = 7, 14, 16, 20, 21, 22, 28, 42.

Conard, How to Know the Mosses, (ed. 2) fig. 44. Grout, Mosses with Hand-lens and Microscope, fig. 14a-b (as *Catharinea*), Moss Flora of North America 1: Pl. 53B (figs. 1-12). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 26, 27 & (ed. 2) Pl. 30, 31 (as *Catharinea undulata*, var. *alleghaniensis*, & var. *minus*). Welch, Mosses of Indiana, fig. 21.–**Fig. 987.**

On rich, humic soil in moist woods and shady ravines and also on clay or mud, especially along streams. Europe, North Africa, Madeira and the Azores, Asia Minor, China, and Japan; Alaska to California; Nova Scotia to Minnestoa, south to the Gulf of Mexico.

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*Atrichum angustatum.* 985. Habit. 986. Leaf.
*Atrichum undulatum.* 987. Leaf.
*Polytrichum piliferum.* 988. Leaf.
*Polytrichum juniperinum.* 989. Leaf. 990. Cross-section of leaf. 991. Lamellae as seen in section.

CHEBOYGAN CO.–Burt Lake, Mud Lake. EMMET CO.–Pellston Hills. MACKINAC CO.–Cut River, Ozark. PRESQUE ISLE CO.–Lamprey Experiment Station.

*Atrichum undulatum* has been called the WAVY CATHARINEA (or, irreverently, the UNDULATING CATHARINE). It grows in moist, hardwood forests on rich, humified soil, whereas *A. angustatum* is more often found on poor, disturbed soils in the open, on roadbanks, for example. As compared with *A. angustatum,* it is usually robust and often quite attractive (at least in a moist, growing condition), with lamellae few and low, covering only about 1/8-1/10 of the upper half of the leaves; in *A. angustatum,* the lamellae are more numerous and higher and cover about 1/4-1/3 the upper half of the leaves.

*Atrichum undulatum* is, in essence, a diploid (or triploid) expression of *A. angustatum.* The sexual relationship usually expressed by such a haploid-diploid species pair is obscured by the fact that in *A. undulatum* antheridia are produced one season

and archegonia the next (making it, more often than not, difficult to demonstrate a monoicous potential).

Our plants can be sorted (although not too successfully) as follows: Var. **undulatum**, relatively small plants of rather dry, weedy habitats, usually appearing dioicous but potentially autoicous, with lamellae 2-4 or rarely 6 cells high and capsules strongly curved and inclined. Var. **altecristatum** Ren. & Card., medium-sized plants of moist woodland habitats, usually appearing dioicous but potentially autoicous, with lamellae 4-6 and sometimes 9 cells high and capsules slightly curved and inclined. Var. **oerstedianum** (C. M.) Crum, large, dioicous plants (usually more than 3 cm. high), in wet habitats, with lamellae 4-6 cells high and especially long, narrow, somewhat curved and inclined capsules (often more than 5 mm. long). The var. *altecristatum,* best recognized by its well-developed lamellae approaching those of *A. angustatum,* appears to have twice the chromosome number as *A. undulatum* var. *undulatum.*

**Atrichum crispum** (James) Sull. occurs in Michigan's Upper Peninsula on wet banks of ditches or woodland streams. It resembles *Mnium* in aspect and has smooth leaves not or slightly toothed at back, few, low, and inconspicuous lamellae, large cells (25-40 $\mu$ wide), and short capsules (2-3 mm. long), tapered to the neck.

## 2. **Polytrichum** Hedw.

Coarse and robust, rigid plants in loose or dense, dark, green, brownish, or bluish-green tufts. Leaves erect or erect-spreading when dry, erect- to wide-spreading and ± recurved when moist, long-lanceolate from an enlarged, sheathing base, usually ± awned, almost entirely covered on the upper surface from the shoulders to the apex by crowded, green lamellae with mostly differentiated terminal cells; margins plane, erect, or abruptly inflexed, entire or coarsely toothed above the shoulders, unbordered; costa broader and thicker above the shoulders, often toothed at back toward the apex, usually excurrent as a ± elongate, toothed awn or hair-point; cells of the upper lamina bistratose nearly to the margins, smooth and thick-walled, subquadrate to hexagonal, those at the shoulders very incrassate and transversely oblong, the cells of the sheath oblong or oblong-linear and yellow-brown, narrower and paler at the margins. Dioicous (or very rarely autoicous); perichaetial leaves not much differentiated but sometimes considerably elongate. Setae single; capsules suberect to horizontal, cubic or prismatic, 4-6-angled, gradually or abruptly narrowed to a short, thick apophysis; annulus none or poorly differentiated in a single row; operculum rostrate from a flat or convex base; stomata large and numerous, somewhat immersed, 1-2-celled, in the upper part of the apophysis or in a constriction between urn and apophysis; peristome teeth 64. Calyptrae densely pilose.—These are the HAIR CAP MOSSES; the generic name too refers to many hairs felting the calyptra. The large capsules, frequently broken off and apparently eaten by small animals (perhaps mice or rabbits), resemble grains of wheat. The name BIRD WHEAT is sometimes used for various species of *Polytrichum. Polytrichum* is almost always an indicator of acid conditions.

1. Leaves ending in a hyaline hair-point — 1. *P. piliferum*
1. Leaves not ending in a hyaline hair-point
  2. Leaf margins entire, abruptly inflexed above the shoulders and covering the lamellae
    3. Plants of bogs, growing in compact tufts and matted with rhizoids well up the stems; leaves not at all curved when dry, not conspicuously awned — 2a. *P. juniperinum* var. *affine*
    3. Plants generally in dry habitats, growing in loose tufts, only moderately radiculose at or near the base of the stems; leaves usually somewhat curved when dry, ending in a short to fairly long, reddish awn — 2. *P. juniperinum*
  2. Leaf margins toothed, plane or erect, not inflexed or covering the lamellae

4. Terminal cells of lamellae clearly notched (as seen in section); capsules deeply constricted between urn and apophysis; exothecial cells bulging, with a central thin spot
5. *P. commune*

4. Terminal cells not or very slightly notched; capsules not or only slightly constricted between urn and apophysis; exothecial cells not bulging, without a central thin spot
5. Terminal cells of lamellae subquadrate or transversely oblong, flat-topped or sometimes retuse
4. *P. ohioense*

5. Terminal cells rounded or narrowly elliptic, not much differentiated from other cells of the lamellae
6. Terminal cells of lamellae narrowly elliptic; cells of leaf sheath oblong-linear; margin of upper portion of leaf very narrow (usually less than 4 cells wide), the cells about 10-12 $\mu$ wide
3. *P. formosum*

6. Terminal cells rounded or shortly oval; cells of sheath shorter (3-5:1), oblong; margin of upper part of leaf somewhat wider, the cells about 15-18 $\mu$ wide
3a. *P. formosum* var. *aurantiacum*

1. **Polytrichum piliferum** Hedw.—Relatively short, stout plants (1-4 cm. high) in loose, brown or glaucous-green tufts. Stems comose above a naked and flexuose base. Leaves erect when dry, erect-spreading when moist, 4.5-7 mm. long, lanceolate from a broader base, stoutly needle-like above the shoulders because of broadly infolded, subentire margins, ending in a long, hyaline, spinulose (or rarely smooth) hair point; lamellae about 24-29, crenate-dentate in profile, 5-7 cells high, with marginal cells conic or pyriform and mammillose in section. Setae 20-43 mm. long; capsules erect when young, inclined when mature, 2-3.5 mm. long, cubic to short-prismatic, sharply 4-5-angled, strongly constricted between urn and apophysis; annulus a single row of cells; stomata in the constriction between urn and capsule. Spores 8-13 $\mu$.—n = 6, 7; 2n = 14.

Conard, How to Know the Mosses, (ed. 2) fig. 48g. Darlington, Mosses of Michigan, fig. 147. Grout, Mosses with Hand-lens and Microscope, Pl. 17g-h, p, Moss Flora of North America 1: Pl. 64C (figs. 1-13). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 28, (ed. 2) Pl. 32 & 64. Welch, Mosses of Indiana, fig. 31.—**Fig. 988.**

On dry, often sandy or gravelly soil, usually in exposed places, commonly on thin soil over rocks, bare roadbanks, sunny knolls or trail banks in forests, and often in old fields. Circumpolar; southern South America and Australia; Greenland to Alaska, south to California, Colorado, Iowa, Ohio, and North Carolina.

CHEBOYGAN CO.—Above the Gorge of Carp Creek, Pine Point, Vincent Lake, Smiths Bog, Mud Lake, Little Lake 16, Weber Lake. EMMET CO.—Stutsmanville, French Farm Lake. MACKINAC CO.—Bois Blanc Island, St. Martins Bay, Ozark, Hendricks. PRESQUE ISLE CO.—Huron Beach, Rainy River Falls, Shoepac Sink Holes.

Easily recognized by hyaline hair-points and inflexed leaf margins.

Hughes (New Phytol. 61: 266-273. 1962) has studied the effects on daylength on the development of the sporophyte of this species. Marsh and Koerner (Ecology 53: 489-493. 1972) studied its role in stabilizing dune sands along the shores of Lake Superior.

2. **Polytrichum juniperinum** Hedw.—Plants rather small to fairly robust, in loose, green, bluish-green, or red-brown tufts 1-13 cm. high. Stems moderately radiculose at or near the base. Leaves straight or ± curved and erect, erect-spreading, or rarely wide-spreading when dry, spreading or wide-spreading when moist, 4-8 mm. long, lanceolate and needle-like above the shoulders because of broadly infolded, entire margins (the sheathing base 1-2.5 mm. long), acuminate, ending in a short to fairly long, red or brown, toothed awn; costa excurrent, usually toothed at back above; lamellae 23-41, crenate in profile, 6-7 cells high, the marginal cells in section

ovoid-conic, with thick, smooth, hyaline walls. Perichaetial leaves elongate, with long, slender awns. Setae 20-60 mm. long; capsules suberect to horizontal, longer than broad, 2.5-5 mm. long, dark-brown and somewhat glaucous, sharply 4-angled, deeply constricted to the short apophysis; annulus none; exothecial cells not or somewhat bulging, with a rounded or elliptic, central thin spot; stomata with 2 guard cells, in the constriction between urn and apophysis. Spores 8-9 $\mu$.–n = 6, 7, 14; 2n = 14.

Conard, How to Know the Mosses, (ed. 2) fig. 48a-f. Grout, Mosses with Hand-lens and Microscope, fig. 17o, o′, Moss Flora of North America 1: Pl. 64B (figs. 1-10). Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 29, (ed. 2) Pl. 33. Welch, Mosses of Indiana, fig. 29.–**Fig. 989-991.**

On soil and rocks, usually in dry, exposed or partially shaded places, frequently on bare roadbanks, in dry, open woods, or on sunny knolls in moist woods, dry heaths, pastures, etc. Widespread in both Northern and Southern Hemispheres and widely distributed in North America.

CHEBOYGAN CO.–Reeses Bog, Gorge of Carp Creek, Iron Bridge, Grapevine Point, Bryants Bog, Vincent Lake, Long Lake, Mud Lake, Weber Lake. EMMET CO.–Maple River Township, Pellston Hills, Carp Lake, Cross Village, French Farm Lake. MACKINAC CO.–Bois Blanc Island, Mackinac Island, St. Martins Point, McKays Creek, Cut River, Ozark, Caffey Corner, PRESQUE ISLE CO.–Lamprey Experiment Station, Evergreen Beach, Shoepac Sink Holes.

Commonly known as JUNIPER MOSS. The leaves resemble the scales of *Juniperus,* in shape and in bluish-green color. The inflexed leaf margins covering the green lamellae protect the photosynthetic tissue from desiccation. This is our most common member of the genus, related to *P. piliferum* and like it characteristic of xeric habitats; it is distinguished by the red awns rather than hyaline hair points.

Both *P. juniperinum* and *P. piliferum* are common on sterile soil in areas altered by fire. In northern Finland and the Swedish Lapland, Uggla (Acta Phytogeogr. Suec. 41: 1-116. 1958) found that they reach their maximum development some 10-20 years after a fire and survive burning well because of rhizoids penetrating the soil.

In Nova Scotia, Nichols (Trans. Conn. Acad. Arts & Sci. 22: 249-467. 1918) noted that the pioneer trees of pastures are generally white spruce which germinate most prolifically in carpets of *Polytrichum.* In our area, *P. juniperinum* would be the most likely *Polytrichum* invading upland pastures. However, Gates (Bot. Gaz. 90: 233-259. 1930) reported that moss-*Cladonia* mats in the aspen stands at Douglas Lake are too dense for seed penetration, absorb water too quickly to allow the soaking of seeds, and because of frequent wetting and drying heave seedlings from the soil. (The role of mossy logs as a seed bed was mentioned, under *Hypnum imponens,* above.)

2a. Var. **affine** (Funck) Brid.–Plants relatively slender but tall and rigid, in very compact tufts 4-16 cm. high, usually dark-brown, nearly always matted with rhizoids well up the stems. Leaves erect and straight when dry, erect-spreading when moist, 3.5-6 mm. long, not conspicuously awned. Setae 18-60 mm. long; capsules 2.5-3 mm. long.–n = 7; 2n = 14.

Grout, Moss Flora of North America 1: Pl. 64B (figs. 12-15), as var. *alpestre.* Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 29 & (ed. 2) Pl. 33 (as *P. alpestre*). Welch, Mosses of Indiana, fig. 30 (as var. *alpestre*).

In bogs and damp heaths, often in *Sphagnum* hummocks, sometimes forming extensive turfy mats in burned-over peatlands. Circumpolar; South .America; Greenland to Alaska, south to Washington, Colorado, Illinois, Ohio, and North Carolina.

CHEBOYGAN CO.–Reeses Bog, Iron Bridge, Bryants Bog, Gleasons Bog, Gates Bog, Mud Lake, Grass Bay, Little Lake 16, Weber Lake. EMMET CO.–Maple River Township, Stutsmanville, Galloway Bog, Wycamp Lake, Cecil Bay, Conway Bog. MACKINAC CO.–Epoufette, Ozark, Hendricks. PRESQUE ISLE CO.–Hammond Bay, Evergreen Beach, Loon Lake, Clinton Lake.

The var. *affine* can be recognized by long stems compacted together by a woolly growth of rhizoids and also by its occurrence in boggy habitats where it often serves as an indicator of fire. It may also indicate dry, late stages of bog succession. The tops of old *Sphagnum* hummocks often support a good growth of *Polytrichum* and species of *Cladonia.* The *Polytrichum* may represent a peak development rather than a recent invasion, however, as *Sphagnum* hummocks are often made possible in the first place by support offered by *Polytrichum.*

3. **Polytrichum formosum** Hedw.—Moderately robust, dark-green or brownish plants in loose tufts about 4-7 cm. high. Leaves loosely erect or erect-spreading when dry, flexuose-spreading to wide-spreading and recurved when moist, 6.5-10 mm. long, lance-acuminate from a sheathing base 1.5-2.5 mm. long, ending in a brown or red-brown, toothed point; margins erect, sharply serrate nearly to the sheath, the unistratose margin about 2/3 up the leaf 4-7, sometimes 10 cells wide; lamellae covering most of the leaf width above the shoulders, 22-58, entire in profile, 3-7 cells high, the marginal cells in section narrowly conic to elliptic, with somewhat thickened, hyaline or pale-brown walls, smooth; costa rather shortly excurrent, toothed at back near the tip; median cells of sheath long and narrow, oblong-linear; perichaetial leaves not much differentiated. Setae 35-50 mm. long; capsules 4-5 mm. long, 4-angled, weakly constricted between urn and apophysis, pale- or yellow-brown, suberect to horizontal; annulus none; exothecial cells not bulging, without a central thin spot; stomata 1- or 2-celled. Spores 11-13 $\mu$.—n = 7, 14; 2n = 14, 17.

Conard, How to Know the Mosses, (ed. 2) fig. 49e-f. Grout, Moss Flora of North America 1: Pl. 61A. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 72 (as *P. gracile*).—**Fig. 992-994.**

On soil or rocks in damp, hardwood or coniferous woods, often in boggy places. Widespread in both Northern and Southern Hemispheres; Alaska to Newfoundland and south to Oregon and Colorado in the West and the Gulf of Mexico in the East.

CHEBOYGAN CO.—3 miles north of Cheboygan. EMMET CO.—Pellston Hardwoods. MACKINAC CO.—Hendricks, Little Dollar Lake.

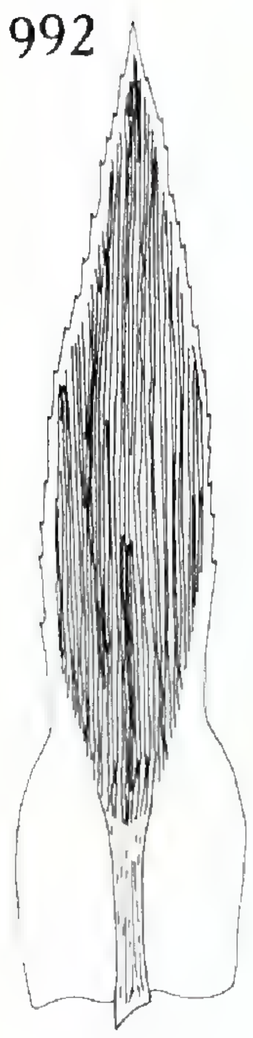
3a. Var. **aurantiacum** (Brid.) C. J. Hartm.—Tufts 2-5, rarely 15 cm. high. Leaves usually somewhat curved when dry, rarely strongly curved-contorted, 5-8 mm. long, lance-acuminate from a broader, oblong base; margins incurved when dry, the unistratose margin about 2/3 up the leaf 5-8, rarely 20 cells wide; lamellae 18-50, 3-6 cells high, subentire to somewhat crenulate in profile, the marginal cells not enlarged, rounded to elliptic as seen in section, with scarcely thickened walls; median cells of sheath rectangular, about 3-5:1. Basal membrane of peristome only slightly projecting above the mouth of the capsule. Spores 17-22 $\mu$.—n = 7, 14.

Conard, How to Know the Mosses, (ed. 2) fig. 49a-d. Grout, Mosses with Hand-lens and Microscope, fig. 16b (as *P. gracile*), Moss Flora of North America 1: Pl. 61B (as *P. gracile*).—**Fig. 995-996.**

On soil and humus in hardwood or coniferous woods. Circumpolar; Labrador to Alaska and south to Colorado, Michigan, and North Carolina.

CHEBOYGAN CO.—Grapevine Point (Douglas Lake), Little Lake 16.

The variety is distinguished from the typical form by broader leaf margins (noticeably inflexed when dry) and short, rectangular cells of the leaf sheath. In typical *P. formosum* the free margin of the lamina is not continuous to the leaf base, whereas in the variety it is broadened at the shoulders and obviously continuous to the base.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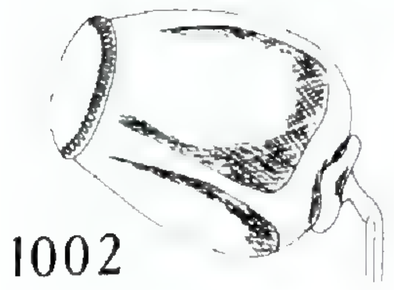
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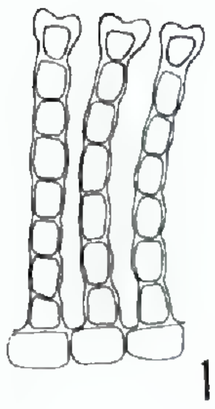
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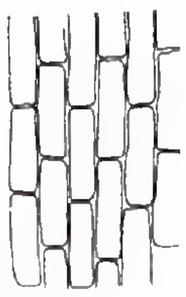
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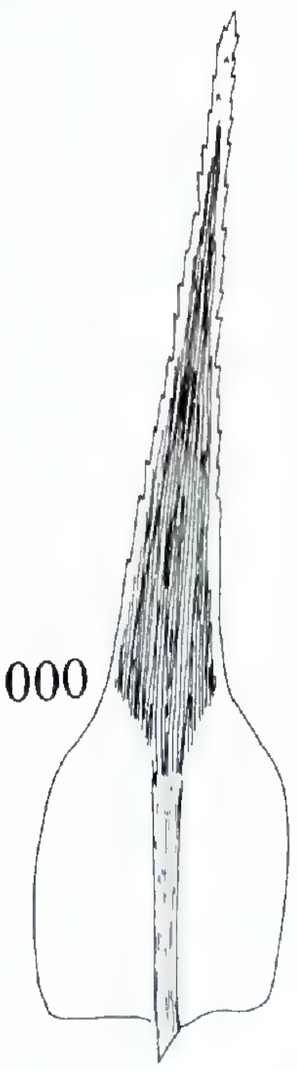
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*Polytrichum formosum*. 992. Leaf. 993. Lamellae as seen in section. 994. Cells of leaf base.
*Polytrichum formosum* var. *aurantiacum*. 995. Leaf. 996. Cells of leaf base.
*Polytrichum ohioense*. 997. Lamellae as seen in section. 998. Capsule.
*Polytrichum commune*. 999. Habit. 1000. Leaf. 1001. Lamellae as seen in section. 1002. Capsule. 1003. Calyptra. 1004. Portion of peristome.

4. **Polytrichum ohioense** Ren. & Card.—Moderately robust plants in loose, dark-green to brown tufts 1.5-6 cm. high. Leaves erect or erect-spreading when dry, wide-spreading and recurved when moist, 6-10.5 mm. long, long-lanceolate from a sheathing base about 2 mm. long, acuminate, ending in a short, reddish, toothed awn; margins erect and coarsely toothed nearly to the shoulders; lamellae 30-41, covering almost the width of the leaf above the shoulders, entire or nearly so in profile, 3-7 cells high, the marginal cells in section somewhat broader, flat-topped or somewhat retuse, with thick, brown, smooth walls; costa rather shortly excurrent, sparsely toothed at back near the apex. Dioicous or rarely autoicous; perichaetial leaves not

much differentiated. Setae 15-85 mm. long; capsules 2-5 mm. long, pale-brown, suberect to strongly inclined, not or only slightly constricted between urn and apophysis, 4- or rarely 5-angled; annulus none; exothecial cells not bulging, without a central thin spot; stomata numerous (but difficult to observe), with 2 guard cells or consisting of a central slit in a single guard cell. Spores 11-13 $\mu$.—n = 14.

Conard, How to Know the Mosses, (ed. 2) fig. 50e-g. Grout, Mosses with Hand-lens and Microscope, fig. 16a (as *P. smithiae*), 17e, Moss Flora of North America 1: Pl. 62A. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 28, (ed. 2) Pl. 32. Welch, Mosses of Indiana, fig. 26.—**Fig. 997-998.**

On soil or humus in woods. Circumpolar; widespread in eastern North America; New Mexico.

CHEBOYGAN CO.—Carp Creek, Colonial Point, Mud Lake. EMMET CO.—Pellston Hills, Carp Lake. MACKINAC CO.—Cut River.

*Polytrichum ohioense* resembles *P. formosum* in the appearance of gametophytes and sporophytes, but the flattened marginal cells of the lamellae, as viewed in section, are distinctive. They may be somewhat retuse, but those of *P. commune* are broader and more conspicuously notched. The wet habitat of *P. commune* is very different from the mesic woodlands favored by *P. ohioense*. (*Polytrichum ohioense* can often be spotted in the field by yellowish setae.)

5. **Polytrichum commune** Hedw.—Robust, dark-green or brownish plants in loose or fairly dense tufts 4-45 cm. high. Stems usually erect from a flexuose and decumbent base. Leaves erect or somewhat spreading at least at the tips and ± rolled when dry, spreading to recurved when moist, 6-10 mm. long, lance-acuminate from a sheathing base about 2-3 mm. long (the yellow-brown base often shiny and conspicuous when dry); margins plane or erect, sharply serrate nearly to the sheath; costa excurrent, ± toothed at back; lamellae 21-55, covering nearly all the leaf above the shoulders, 4-9 cells high, entire or slightly crenulate in profile, the marginal cells in section somewhat to considerably wider, notched or depressed in the middle (and occasionally divided into 2 cells), with thick, brown, smooth walls. Perichaetial leaves long and narrow (about 9-15 mm. long), scarious-margined, with costa long-excurrent. Setae 50-90 mm. long; capsules 3-5 mm. long, red-brown and ± glaucous, 4-angled, deeply constricted above a distinct apophysis; annulus none; stomata with 2 guard cells, in the constriction between urn and apophysis; exothecial cells bulging, with a circular to slit-like thin spot. Spores 8 $\mu$.—n = 6, 7, 14.

Breen, Mosses of Florida, Pl. 124. Conard, How to Know the Mosses, (ed. 2) fig. 50a-d. Grout, Mosses with Hand-lens and Microscope, fig. 17a-d, f. Moss Flora of North America 1: Pl. 63. Jennings, Mosses of Western Pennsylvania, (ed. 1) Pl. 29, (ed. 2) Pl. 33. Welch, Mosses of Indiana, fig. 27, 28 (as var. *perigoniale*).—**Fig. 999-1004.**

On soil in wet, boggy woods. Nearly cosmopolitan; Greenland to Alaska and south to California, Arizona, Wyoming, Texas and Florida.

CHEBOYGAN CO.—Reeses Bog, Douglas Lake, Smiths Bog, Bryants Bog, Nichols Bog, Vincent Lake, Mud Lake, Mullett Lake, Weber Lake. EMMET CO.—Pellston, Stutsmanville, Wycamp Lake. Wycamp Creek, French Farm Lake, Big Stone Bay. MACKINAC CO.—Epoufette, Cranberry Lake, Hendricks, McNamara Pond.

The COMMON HAIR CAP MOSS is especially characteristic of wet habitats, at the edge of coniferous swamps or in the moat surrounding bogs, for example. It is not particularly common in our area.

Linnaeus wrote that this large and conspicuous moss was used in Lapland for stuffing pillows and other bedding and that he had often slept on a bed of *Polytrichum* during his travels in the North. (Withering reported that bears use it too!) In Great Britain it was occasionally used in former times in making small brooms for dusting curtains, carpets, and beds. Dillenius said that an oil expressed from it was used by ladies of his time on their hair—a truly fine application of the Doctrine of Signatures!

The leaf bases are usually exposed and shiny, giving a good clue to the identity of the plants, but I depend entirely on the appearance of the terminal cells of the lamellae in cross-sections of leaves. They are broad and notched in *P. commune.* In *P. ohioense,* they are not much broader than the other cells of the lamellae and flat (or occasionally slightly retuse). *P. ohioense,* of course, grows in moist hardwood forests, not in boggy places.

*Pogonatum* is very similar to *Polytrichum,* especially in gametophytic structure and appearance. The calyptra is hairy, as in *Polytrichum,* but the capsules are cylindric. In northern Michigan we have **Pogonatum alpinum** (Hedw.) Röhl. (at the Lower Falls of the Tahquamenon River in Chippewa County, for example). It resembles *P. commune* in some ways. The leaves are concave or subtubulose and toothed; and the lamellae end in papillose cells which are vertically elliptic as seen in section. The capsules are broad and suberect or curved and inclined, with smooth exothecial cells and many stomata in the region of the neck. Elsewhere in the Upper Peninsula is **P. dentatum** (Brid.) Brid., also known as *P. capillare* (Mx.) Brid. The plants are small, with flat, coarsely toothed leaves. The terminal cells of the lamellae are papillose and flat-topped as viewed in section. The capsules are erect and narrow, with bulging exothecial cells and no stomata.

Similar in many ways to *P. alpinum* is **P. urnigerum** (Hedw.) Par. (a montane species likely to occur in the Lake Superior region). When fresh, it has an attractive bluish color quite different from the dark green of *P. alpinum.* It is further distinguished by smaller size and growth in looser tufts. The leaves are flatter and broader; the marginal cells of the lamellae are shorter (with the lumen resembling in section the gabled end of a house); and the capsules are erect and narrowly cylindric, with bulging exothecial cells and no stomata. The capsules of *P. alpinum* are nothing like those of *Pogonatum urnigerum* or any other *Pogonatum* in a strict sense; see Smith (Mem. N.Y. Bot. Gard. 21(3): 1-83. 1972) for a consideration of relationships.

We do not have **Pogonatum pensilvanicum** (Hedw.) Par., which grows as scattered individuals from an abundant, persistent protenema on roadbanks farther to the east.

Tansley and Chick (Ann. Bot. 15: 1-33. 1901) demonstrated some startling resemblances to the conductive tissues of *Polytrichum* and the so-called vascular plants. The stems of *Polytrichum* have a central core of elongate cells (hydroids) similar in shape to tracheids and an enveloping sheath of cells suggestive of sieve tubes (leptoids) and companion cells. The vascular cylinder is enclosed by endodermis with Casparian strips, and leaf traces join the midrib of the leaves to the conductive elements of the stem. The radial arrangement of "xylem" and "phloem" in the decumbent base and the concentric arrangement in the erect, leafy portion of the stem are similar to those in the primary steles of roots and stems, respectively.

The seta has a central cylinder of less obviously differentiated tissues, owing perhaps to overall simplication of the sporophyte. Spiral and annular thickenings have been observed in comparable tissues in the columella of a hornwort, *Dendroceros,* by Proskauer (Phytomorph. 10: 1-19. 1960). Finocchio (Bull. Torrey Bot. Club 94: 18-20. 1967) reported vessel-like cells in the gametophytic "cortex" of some pleurocarpous mosses having only a small central strand or none. These cells, living at maturity, are

moderately elongate, with broad, oblique end walls and large, simple pits on the sides and ends, sometimes in a scalariform pattern. Arrangement in short vertical series suggests a conductive function. Such cells may be primitive or vestigial vascular elements—or phylogenetically quite unrelated to vascular tissues!

In mosses, including *Polytrichum,* the movement of water is mainly external, although some is internal and presumably by way of the xylem-like cells. [See the discussion and references following *Sphagnum recurvum* above. Some further information on water relations is provided by Anderson and Bordeau (Ecol. 36: 206-212. 1955); Buch (Soc. Sci. Fenn. Comm. Biol. 9(16): 1-44. 1945, 9(20): 1-60. 1947); Klepper (Bryol. 66: 41-54. 1963; Nova Hedwigia 15: 13-20. 1968); Roberts and Haring (Ann. Bryol. 10: 97-114. 1938.)] Callus plugs develop in the sieve tubes of *Polytrichum,* and Eschrich and Steiner (Planta 74: 330-349. 1967) have demonstrated that carbon-labeled assimilates indeed move in this "phloem."

The stems of *Polytrichum* are hard and woody, befitting their size, but the vascular tissue is not lignified. Lignin provides at the cellular level the strength and stability necessary for nearly all plants that successfully cope with a dry land environment. It is a constant feature of vascular plants, large or small, from the fossil Psilophytales upward. There is no obvious need for lignin in the low-growing bryophytes. Among North American examples, lignin is absent from all structures of the liverworts *Marchantia, Riccia,* and *Jungermannia* and from gametophytes of the mosses *Bryum, Rhodobryum, Mnium, Funaria,* and *Polytrichum,* although present in some peristomes (Siegel, *The Plant Cell Wall,* 1962; Amer. Jour. Bot. 56: 175-179. 1969). Lignin has been found in *Sphagnum,* of a different type from that in higher plants (Black *et al.,* Jour. Applied Chem. 5: 484-492. 1955; Bland *et al.,* Phytochem. 7: 1373-1377. 1968). It occurs in two of the giant mosses of New Zealand, *Dawsonia* and *Dendroligotrichum,* both somewhat related to *Polytrichum* (Siegel, *loc. cit.*), and Scheirer (Bryol. 75: 305-314. 1972) has demonstrated that in *Dendroligotrichum* it is indeed associated with vascular tissue, though not limited to the "xylem."

Lignin defies chemical definition, and therefore one can scarcely draw conclusions concerning evolutionary origins from the foregoing. However, it is worthy of comment that both the Polytrichaceae and the Dawsoniaceae give morphological evidence of a primitive nature and a relationship to the Psilophytales, and lignin supplies a chemical link. The Dawsoniaceae, centered in the Antipodes, are phytogeographically associated with many other primitive organisms, plant and animal.

References on the structure and significance of conductive tissue in mosses, especially the Polytrichaceae, include Berthier *et al.* (Compte Rendu Séanc. Acad. Sci. Paris 272: 2868-2871. 1971), Eschrich & Steiner (Planta 82: 33-49. 1968), Hébant (Natur. Monspel., Bot. 18: 293-298. 1967; Compte Rendu Séanc. Acad. Sci. Paris 226: 2190-2192. 1968; Rev. Bryol. et Lichén. 36: 721-731. 1970; Phytomorph. 20: 390-410. 1971), Kawai (Ann. Rept. Bot. Gard. Univ. Kanazawa 2: 1-25. 1969, 16: 21-60, 83-111. 1971), Kawai & Ikeda (Sci. Rept. Kanazawa Univ. 15: 71-98. 1970). Lorch (*in* Linsbauer, *Handbuch der Pflanzenanatomie* II, 2, 7(1): 1-358. 1931), Smith (Mem. N.Y. Bot. Gard. 21(3): 1-83. 1971).

Vascular tissue is well developed in large, erect mosses, especially in the Polytrichaceae and Dawsoniaceae, but progressively less evident in smaller acrocarps and low-growing, matted pleurocarps. Because they have no provision for lignified support or secondary growth and have no specialized food storage or other provision for dormancy, mosses have remained small and adapted themselves to small niches not suited to plants more liberally endowed in size and structure and have thus escaped the evolutionary pressures acting on larger terrestrial plants. Reduction in size and simplification of structure (often associated with a telescoping of the life cycle) has been a major force in the evolution of bryophytes. The uncertainties of fertilization by

swimming sperms have been largely avoided by a trend toward monoecism and, especially, asexual forms of propagation. [The phylogenetic meaning of *Buxbaumia's* highly simplified gametophyte is discussed by Goebel (Flora 76: 92-104. 1892; Ann. Bot. 6: 355-360. 1892) and van der Wijk (Buxbaumia 1: 2-4. 1947).]

The mosses are not direct offshoots from the aquatic green algae but reduced from primitive vascular plants already adapted to life on land. Swimming sperms, a well-defined alternation of generations, and dependence of sporophyte on gametophyte fit as well in a downgrade sequence from vascular plants as in an upgrade series from algae. Other evidence of a terrestrial ancestry includes cytokinesis by cell plate formation (rather than centripetal pinching) and spores developed in tetrads as a direct result of meiosis, as well as presence of a cuticle, stomata in the capsule wall, and peristome mechanisms for spore dispersal. Few mosses are truly aquatic and even those that are, such as *Fontinalis,* are related to terrestrial groups and have structures like peristomes and stomata obviously suited to aerial functions. Also the spores of mosses have a size suited to wind transport and no obvious adaptations for aquatic dispersal.

It is convenient to treat bryophytes as a single division because of obvious similarities in life cycle. Yet they are polyphyletic in origin. I recognize five lines of evolution as classes: Hepaticopsida, Anthocerotopsida, Sphagnopsida, Andreaeopsida, and Bryopsida. The liverwort-like Anthocerotopsida may be derived from more highly organized vascular plants, like the mosses. Hepatics may have come more directly from green algae; yet the oldest fossil liverworts show some evidence of vascularization not exhibited by any of the algae.

The evolution of bryophytes is difficult to follow because of independent trends of adaptative change in gametophyte and sporophyte and also because morphologists have been loath to recognize the homology of the two generations–hence favoring such terms as dioicous rather than dioecious, phyllid rather than leaf, and caulid rather than stem. However, the genetic potential is there, whether the chromosome number is haploid or diploid. Sporophytic tissue can be made to regenerate as leafy diploid gametophytes. Gametophytes can be made to bypass fertilization and form sporangia by an abnormal budding process. Such buds can be directed toward sporangial development or gametophytic expression depending on conditions of culture. Thus the chromosome level does not control the expression of characters and the two generations, gametophyte and sporophyte, must indeed be homologous. Because the sporophyte normally remains attached to the gametophyte, it is subject to different environmental pressures, expresses itself differently, and evolves independently within the framework of identical genes. It is the conditions of growth that have kept the sporophyte from expressing its potential as a leafy, sexual plant. It follows for similar reasons that vascular tissue in the gametophyte and the sporophyte are homologous and also homologous to xylem and phloem in the higher plants.

I see the common ancestor of mosses and Psilophytales (and all other vascular plants) as terrestrial but low growing and suited for fertilization under conditions of intermittent wetness. The sporophyte was attached to a small, simple gametophyte, much as in *Anthoceros*; it was unbranched and leafless, ended in a sporangium, and had the essential elements of vascularization. From that point, mosses arose as the gametophyte made do with microhabitats and developed into a leafy form, first erect and simple, later prostrate and branched; higher plants specialized in an elaboration of the sporophyte, beginning with dichotomous branching, later developing leaves, sporophylls, heterospory, seeds, roots, secondary growth, etc. *Cooksonia,* of the Upper Silurian, is the earliest known vascular plant and close to the hypothetical ancestor of mosses, but it has a forked sporophyte. The early development of mosses has not yet been discovered in the fossil record. *Cooksonia* is older than the oldest "probable" fossil moss, *Muscites plumosus* of the Lower Carboniferous (Thomas, Ann. Bot. 36:

155-161. 1972). The undoubted mosses of the Permian, much later, are highly evolved and far removed from the level of gametophytic complexity presented by the Polytrichaceae, which in terms of extant mosses seem primitive.

Reviews of bryophyte fossils are given by Jovet-Ast (*Traité de Paléobotanique*, vol. 2, pp. 17-186. 1967) and Lacey (Biol. Rev. 44: 189-205. 1969).

## ADDENDUM

**Sphagnum quinquefarium** (Lindb. *ex* Braithw.) Warnst. has been found once in Michigan (in a *Thuja* swamp at Epoufette, Mackinac Co., *H. Crum & N. G. Miller*, July 28, 1966). It is light-green to pink and resembles *S. warnstorfii* when dry because the narrow branch leaves are arranged in 5 spiral rows and spreading at the tips. However, the pores on the outer surface of the branch leaves are larger and elliptic. The stem leaves are rather small and oblong-triangular, ending in a short, acute, concave tip; the hyaline cells are often 1-2-divided, not or somewhat fibrillose, and the border is conspicuously differentiated at the base. Pores are often found in the stem cortex, but the small, pointed stem leaves with commonly divided hyaline cells and the dry aspect of the branch leaves separate this species from *S. russowii.*

# A DICTIONARY OF TERMS RELATING TO MOSSES

"When I use a word," Humpty Dumpty said in rather a scornful tone, "it means just what I choose it to mean–neither more nor less."

Lewis Carroll, *Through the Looking Glass*

William C. Steere used to emphasize the importance of terminology by reading to his classes in systematic botany this account of how horses are harnessed in Germany:

The man stands up the horses on each side of the thing that projects from the front end of the wagon, throws the gear on top of the horses, and passes the thing that goes forward through a ring, and hauls it aft, and passes the other thing through the other ring and hauls it aft on the other side of the other horse, opposite to the first one, after crossing them and bringing the loose end back and then buckles the other thing underneath the horse, and takes another thing and wraps it around the thing I spoke of before, and puts another thing over each horse's head, and puts the iron thing in his mouth, and brings the ends of these things aft over his back, after buckling another one around under his neck, and hitching another thing on a thing that goes over his shoulders, and then takes the slack of the thing which I mentioned a while ago and fetches it aft and makes it fast to the thing that pulls the wagon, and hands the other things up to the driver.

Mark Twain, *A Tramp Abroad*

ABAXIAL–away from the stem or axis, opposed to *adaxial*; (see also *dorsal*).
ACAULESCENT–stemless or apparently so.
ACCRESCENT–increasing in size.
ACICULAR–needle-like.
ACIDOPHILE–a plant of acid habitats, an *oxylophile.*
ACINACIFORM–scimitar-shaped.
ACROCARPOUS–producing the sporophyte at the end of a stem or main branch (opposed to *pleurocarpous*). Acrocarpous mosses generally grow erect in tufts (rather than mats) and are sparsely branched.
ACROGENOUS–with an apical meristem.
ACUMEN (pl. *acumina*)–a slender, tapering point; ACUMINATE–slenderly tapered.
ACUTE–sharply pointed (less than 90°).
ADAXIAL–toward the stem or axis, opposed to *abaxial*; (see also *ventral*).
ADHERENT–sticking to another organ, as opposed to *coherent,* or sticking to an organ of the same kind.
ADNATE–fused with or attached to another organ.
AERUGINOSE–bluish-green, the color of copper rust (verdigris).
AGGREGATE–clustered.
ALAR CELLS–cells at the basal angles of a leaf, often differentiated in shape, size, or color.
ALVEOLATE–with depressions on the surface, sometimes applied to spores.
AMORPHOUS–without definite shape.
AMPHIGASTRIA–underleaves of leafy liverworts, representing a third row, often reduced or even lacking; in a few mosses, smaller leaves on the upper surface of stems and branches, variously differentiated from the lateral leaves.
AMPHITHECIUM–an embryonic tissue of a developing capsule, surrounding the central *endothecium.*
AMPLEXICAUL–clasping the stem.
ANASTOMOSING–interconnecting, sometimes applied to the joining and rejoining in irregularly divided peristome teeth.
ANDROECIUM–the male inflorescence.
ANDROGYNOUS–male and female sex organs in the same inflorescence.
ANISOSPOROUS–producing spores of two overlapping size classes in the same capsule (sometimes associated with asexual dimorphism); differentiated from the heterosporous condition of

higher plants in which the microspores and megaspores are of two distinct sizes and are produced in different structures.

ANNOTINOUS–in yearly growths (the junction with the previous year's growth evident because of crowded leaves or other signs of interrupted growth).

ANNULUS–a ring of differentiated cells between the mouth of the capsule and the operculum, aiding in dehiscence; ANNULAR–ring-like.

ANTHERIDIUM–the male reproductive organ, a globose to broadly cylindric, stalked structure producing sperms (*antherozoids*).

ANTHROPOCHOROUS, ANTHROPOGENOUS–associated with man or aided in dispersal by the activities of man.

ANTRORSE–directed forward or (in reference to papillae) toward the leaf tip.

APICULUS–a short, abrupt point; APICULATE–abruptly short-pointed (*mucronate* is even shorter; *cuspidate* is longer and stouter).

APOPHYSIS–a swelling or expansion at the base of the capsule (also called an *hypophysis*).

APPENDICULATE–with short, transverse projections.

APPRESSED–lying close together; closely applied to the stem.

APPROXIMATE–close together.

ARBOREAL–growing on trees.

ARCHEGONIUM–the female reproductive organ, a flask-shaped structure producing an egg.

ARCUATE–curved like a bow.

ARENICOLOUS–growing on sand.

AREOLAE–small, angular areas forming a network.

AREOLATION–the cellular network of a leaf.

ARISTATE–bristle-pointed, ending in an awn (*arista*).

ARTICULATE–with thickened joints, jointed.

ASCENDING–directed obliquely upward.

ASPERULOUS–slightly roughened.

ASSURGENT–directed upward.

ASTOMOUS –without an operculum, hence indehiscent; also called *cleistocarpous.*

ATTENUATE–narrowly tapered.

AURICLE–a small, ear-like bulge or lobe at the basal margins of a leaf; AURICULATE–with basal auricles.

AUTOICOUS–with archegonia and antheridia in separate inflorescences on the same plant; CLADAUTOICOUS–with the male inflorescence on a separate branch; GONIOAUTOICOUS –with the male inflorescence bud-like and axillary on the same stem or branch as the female inflorescence; PSEUDAUTOICOUS–with dwarf male plants epiphytic on the female; RHIZAUTOICOUS–with the male inflorescence on a very short branch attached to the female stem by rhizoids (and appearing to be a separate plant).

AWN–a bristle- or hair-point, usually formed by an excurrent costa.

AXIL–the angle between leaf and stem; AXILLARY–in the leaf axils.

BASAL MEMBRANE–a delicate but often well-developed membrane at the base of the inner peristome of many mosses, commonly terminating in segments and cilia.

BEAK–the prolonged apex of an operculum; also called a *rostrum.*

BI-–a prefix, meaning 2; BICOSTATE–with 2 nerves or costae; BICUSPIDATE–with 2 short points; BICRUROUS–with 2 divisions (or "legs"); BIFARIOUS–in 2 rows; BIFID and BIFURCATE–forked, divided into 2 parts; BIGEMINATE–doubly paired, in 4's; BILOBED–with 2 lobes; BINATE–in pairs; BIPARTITE–in 2 parts; BIPINNATE–twice-pinnately branched; BISERIATE–in 2 layers.

BLOOM–a covering of powdery or waxy material causing a whitish or bluish overcast; see also *glaucous.*

BOG–a waterlogged open type of vegetation poor in mineral nutrition because all water is derived from precipitation, rather than from the soil; often used in this work and elsewhere for *poor fens* (which see)). A bog is usually dominated by *Sphagnum.*

BORDERED–having margins differentiated from the rest of the leaf in shape, size, color, or thickness of cells.

BOREAL–northern, especially referring to the boreal coniferous forest which extends around the Northern Hemisphere, from the treeless tundra southward to temperate latitudes (and deciduous forests).

BRACTS–specialized leaves surrounding reproductive organs.

BROOD BODIES–reduced buds, leaves, or branches (*propagula*) or small, globose, ellipsoidal, or cylindric to filamentous, septate bodies (*gemmae*) serving in vegetative reproduction.

BULBIFORM–bulb-shaped.

BULBIL–a small, reduced bulb-shaped bud serving in vegetative reproduction.

BYSSACEOUS–divided into threads.

CADUCOUS–deciduous, regularly falling off.
CAESIOUS–bluish or bluish-glaucous.
CAESPITOSE–tufted, growing in cushions or sods.
CALCAREOUS–containing calcium carbonate; limestone or dolomite rocks.
CALCIPHILE–a plant of calcareous habitats; opposed to *calciphobe* (*calcifuge*), a plant not occupying calcareous habitats; CALCICOLOUS–living in calcareous habitats.
CALLOSE–hard and thick.
CALYPTRA–a membranous hood over the developing sporophyte, developed from the archegonium, in true mosses ruptured near the base, carried upward on the elongation of the seta, and continuing growth to form a cap over the capsule.
CAMPANULATE–bell-shaped.
CANALICULATE–channeled.
CANCELLATE–lattice-like.
CANCELLINAE–the sharply defined, large, empty and usually hyaline basal leaf cells of the Calymperaceae.
CANESCENT–hoary because of hyaline hair-points on the leaves.
CANOPY FORMERS–with branches borne well above the substrate, as in dendroid forms (cf. *Climacium*).
CAPILLARY–hair-like.
CAPITATE (CAPITULATE)–rounded and compact forming a head-like *capitulum.*
CAPSULE–the spore case, often differentiated into an upper spore-bearing *urn* and a sterile basal portion called the *neck* (which may be considerably differentiated as a broad *apophysis* or *hypophysis*).
CARINATE–keeled like the bottom of a boat.
CARNEOUS–flesh-colored; CARNOSE–fleshy.
CARTILAGINOUS–firm and tough.
CASTANEOUS–chestnut-brown.
CATENULATE–chain-like.
CAULINE–referring to the stem; CAULID–haploid stem of bryophyte; CAULESCENT–having a stem.
CENTRAL STRAND–a small group of elongate cells forming a central axis of some stems.
CERNUOUS–nodding or drooping.
CERVINE–dark-tawny (the color of a deer).
CHARTACEOUS–papery.
CHLOROCYSTS–small, elongate, green cells forming a network enclosing the large, hyaline cells (*leucocysts*) of a *Sphagnum* leaf, also called *green cells* or *chlorophyll cells*; also applied to small, green cells enclosed by layers of hyaline cells in the leaves of Leucobryaceae or mingled with them in *Paraleucobryum.*
CHLOROPHYLLOSE–green, containing chlorophyll.
CILIA–delicate, thread-like structures alternating with the segments of the inner peristome of many mosses; also applied to hair-like appendages fringing leaves or calyptrae; CILIATE–fringed with hairy appendages.
CINEREOUS–ashy-gray.
CIRCINATE–curved in a circle.
CIRCUMBOREAL–widespread in the Northern Hemisphere, circumpolar.
CIRRATE (CIRROSE)–curled.
CLADAUTOICOUS–monoicous, with the male inflorescence on a separate branch.
CLADOCARPOUS–producing the sporophyte at the end of a special, short branch.
CLAVATE (CLAVIFORM)–slender, elongate, and thickened upward, club-like.
CLEISTOCARPOUS–lacking an operculum and hence irregularly dehiscent (opposed to *stegocarpous*).
COALESCED–fused together.
COARCTATE–pressed together, squeezed in, constricted, sometimes applied to strangulate capsules (of *Orthotrichum,* for example).
COCHLEARIFORM–round and deeply concave, shaped like the bowl of a spoon (not snail-like or spiraled as the derivation would suggest).
COHERENT, COHERING–sticking together, sticking to another organ of the same kind.
COLLENCHYMATOUS–with cell walls thickened at the corners; in liverworts such thickenings are called *trigones.*
COLLUM–the tapered base or *neck* of a capsule.
COLUMELLA–the central axis of a capsule around which the spores develop.
COMMISSURE–margin; in branch leaves of *Sphagnum,* the "seam" formed by the adjacent walls of hyaline and green cells; hence, pores along the commissures are arranged along the lateral margins of hyaline cells.
COMOSE–hairy, but used by bryologists to refer to leaves larger and more crowded, forming tufts or *comae* at the stem tips; extremely comose stems may be *rosulate* in appearance.

COMPLANATE–flattened together or compressed in 1 plane.
COMPLICATE–folded lengthwise; COMPLICATE-CARINATE–sharply folded along a keel.
COMPRESSED–flattened.
CONCOLOROUS–of the same color.
CONDUPLICATE–strongly folded along the middle.
CONFERVOID–alga-like, filamentous.
CONFLUENT–merging.
CONNATE–fused, joined together.
CONNIVENT–approaching or meeting at the tips, directed to a single point, converging.
CONSTRICTED–abruptly narrowed.
CONTORTED–bent into irregular curves, irregularly twisted.
CONVOLUTE–rolled together and forming a sheath.
CORDATE–heart-shaped.
CORIACEOUS–tough, leathery.
CORMOPHYTE–archegoniate plants (*i.e.*, bryophytes, ferns and fern allies, seed plants).
CORTEX–differentiated outer layers of a stem or branch, surrounding a central cylinder; CORTICAL–referring to the outer cells of stems or branches; CORTICOLOUS–growing on bark.
COSMOPOLITAN–occurring in all major floristic zones of the world.
COSTA–nerve of a leaf, sometimes double, sometimes single forming a midrib; COSTATE–with a costa; ECOSTATE–without a costa.
CRENATE–with rounded teeth; CRENULATE–with minute, rounded teeth.
CRIBROSE–finely perforated, sieve-like.
CRISPED (CRISPATE)–wavy (like crisp bacon); often used more loosely to mean variously curled, twisted and contorted.
CRISTATE–crested; bearing a crest-like ridge; with a pale margin resembling a crest.
CRYPTOPORE–having *immersed* stomata, with the guard cells sunken below the level of the exothecial cells and often ± covered by them (opposed to *phaneropore*).
CUCULLATE–hooded or hood-shaped; a *cucullate* calyptra is conic and split up 1 side, resembling a monk's hood; also used to describe leaves concave at the tips. A *mitrate* calyptra may be entire at base or several-lobed.
CULTRIFORM–shaped like a knife, in bryology meaning curved and asymmetric, like a short, broad scimitar (apparently an incorrect form resulting from a confusion with *cultiform*, or shaped like a ploughshare).
CUNEATE–wedge-shaped, cuneiform.
CUPULATE–cup-shaped, rounded and swollen.
CUPULIFORM–cupola-like.
CUSHION–with stems ± erect but somewhat radiating to form small tufts (as in *Orthotrichum*).
CUSPIDATE–ending abruptly in a stout, rigid point.
CUTICLE–the non-cellular covering of such organs as leaves or capsules, often variously roughened; epidermal cells of stems are sometimes referred to as *cuticular* or *cortical* cells.
CYATHIFORM–cup-shaped.
CYGNEOUS–curved downward like a swan's neck.
CYMBIFORM–concave and broadly boat-shaped.

DECIDUOUS–falling off.
DECLINATE–descending in an arch.
DECUMBENT–ascending from a prostrate base, lying prostrate but with ascending tips.
DECURRENT–with the margins extending down the stem below the leaf insertion as ridges or narrow wings.
DECURVED–curved downward.
DEFLEXED–bent or curved downward.
DEFOLIATE–denunded of leaves.
DEHISCENT–splitting open, referring to capsules opening by valves or by an operculum, or irregularly.
DELTOID–equilaterally triangular.
DENDROID–branched above a trunk-like base and resembling a tree.
DENTATE–with sharp teeth directed outward; DENTICULATE–finely dentate.
DENUDED (DENUDATE)–with leaves worn off.
DEOPERCULATE–without the operculum, referring to a capsule after the operculum has fallen.
DEPAUPERATE–poorly developed.
DEPRESSED–flattened, low.
DESCENDING–directed gradually downward.
DEXTRORSE–twisted to the right (opposed to *sinistrorse*).
DIAPHANOUS–transparent.

DICHOTOMOUS–equally forked, with paired branches.
DIMIDIATE–split on 1 side (cucullate calyptrae are dimidiate and hooded).
DIMORPHOUS–of 2 forms.
DIOICOUS–with archegonia and antheridia on separate plants, dioecious.
DISCOID (DISCIFORM)–flattened and disc-like or plate-like; male inflorescences may be *discoid* (resembling small flowers), *cupulate* (rounded and swollen), or *gemmiform* (small and bud-like).
DISPOSITIO–see phyllotaxy.
DISTAL–away from the base or point of attachment (opposed to proximal).
DISTICHOUS–in 2 opposite rows.
DIVARICATE–widely spreading from each other.
DIVERGENT–spreading from each other.
DIVISURAL LINE–the median line of a peristome tooth, usually zig-zag, sometimes furrowed.
DORSAL–the *back, lower,* or *abaxial* surface of a leaf, the *outer* surface of a peristome tooth, or the *upper* surface of a flattened plant body; DORSAL LAMINA–in *Fissidens* the portion of the leaf blade at the back of the costa, opposite the sheathing base; DORSAL PLATES–the outer surface of exostome teeth.
DORSIVENTRAL–flattened, with distinct upper and lower surfaces.

ECHINATE–roughened by blunt, spiny projections; ECHINULATE–minutely spiny.
ECOSTATE–without a costa.
EDENTATE–without teeth.
ELLIPTIC–essentially oblong but convex at sides and ends; ELLIPSOIDAL–a solid having an elliptic outline.
EMARGINATE–broad at the apex and shallowly notched (deeper than *retuse*).
EMERGENT–partially exposed, referring to capsules only partly exceeding the tips of the perichaetial leaves.
ENDEMIC–limited to a single country or floristic area.
ENDOHYALOCYST–enlarged, empty, hyaline cell of cancellinae occupying the leaf base in the Calymperaceae.
ENDOSTOME–the inner peristome (usually consisting of segments, often from a basal membrane, frequently alternating with cilia).
ENDOTHECIUM–the inner cell layer of lining of a capsule, forming a spore-sac; usually applied to the inner embryonic tissue of a young capsule (surrounded by the *amphithecium*).
ENERVATE–lacking a costa.
ENSIFORM–sword-shaped.
ENTIRE–not at all toothed.
EPIDERMIS–a single layer of cells at the surface (particularly applied to thallose liverworts).
EPIPHRAGM–in Polytrichaceae, a circular membrane formed by the expanded tip of the columella, partially closing the mouth of the capsule after dehiscence.
EQUITANT–straddling like a rider on horseback, referring to the conduplicate and strongly sheathing leaf bases of *Fissidens.*
ERECT-SPREADING–spreading at an angle of about 45° or less, erecto-patent.
EROSE–irregularly notched or ragged, as though gnawed.
EUTROPHIC–rich in minerals, hence ± basic or alkaline.
EXANNULATE–lacking an annulus.
EXASPERATE–roughened.
EXCAVATE–abruptly hollowed out.
EXCURRENT–extending beyond the apex.
EXOSPORE–the outer wall or surface of a spore.
EXOSTOME–the outer peristome, consisting of *teeth* (only rarely undivided).
EXOTHECIUM–the outermost layer of the capsule wall, made up of *exothecial* cells.
EXSERTED–projecting and exposed, applied to capsules which project beyond the tips of the perichaetial leaves.
EXSICCATI–dried specimens; usually referring more specifically to widely distributed, published sets of specimens, with printed labels, used as standards for comparison and often cited in monographic works.

FALCATE–curved like the blade of a sickle; FALCATE-SECUND–strongly curved and turned to 1 side.
FASCICULATE–bunched together, in bundles or *fascicles.*
FASTIGIATE–with branches nearly parallel and of ± equal length; also erect and columnar, because of the type of branching (like a Lombardy Poplar).
FEN–an open, boggy habitat receiving nutrients from groundwater (*soligenous*), hence more mineral-rich than a bog (*ombrotrophic* in nutrition, receiving water and nutrients only by

precipitation). BOGS are acid; FENS may be acid to neutral or alkaline. RICH FENS are dominated by sedges, with *Sphagnum* a minor element. POOR FENS (often called bogs) are *Sphagnum* dominated and are floristically similar to true bogs but richer in species.

FENESTRATE–with broad, window-like openings, a more extreme condition than *perforate.*

FERRUGINOUS–rusty.

FIBRILLOSE–with fine, fiber-like wall thickenings (*fibrils*); applied to hyaline cells of *Sphagnum* in which the fibrils may be spiral or annular.

FILIFORM–slender and elongate, filamentous, thread-like.

FIMBRIATE–fringed.

FLABELLATE (FLABELLIFORM)–fan-shaped.

FLACCID–soft, limp, flabby.

FLAGELLUM (pl. FLAGELLA)–a slender branch, referring to minute, axillary brood-branches and sometimes to long, slender, tapering stems of branches; FLAGELLATE or FLAGELLIFORM–like the lash of a whip.

FLEXUOSE–slightly and irregularly bent, twisted, or wavy.

FOLIOSE–leafy.

FOOT–the basal absorbing organ of the sporophyte.

FORCIPATE–curved inward like nippers.

FORNICATE–arched.

FOVEOLATE–pitted.

FRONDOSE–closely and regularly branched in 1 plane and resembling a fern frond.

FRUIT–the capsule (or more loosely the sporophyte).

FUGACIOUS–vanishing or readily falling away.

FULVOUS–tawny, dull yellow-brown.

FUNDUS–the base of a peristome tooth.

FURCATE–forked.

FURFURACEOUS–scaly.

FUSCOUS–dull, dark-brown, often tinged with black.

FUSIFORM–narrow and tapered at both ends, spindle-shaped.

GAMETOPHYTE–the dominant, sexual generation; in mosses, the green, leafy plant; in liverworts, the gametophyte may be leafy or thallose.

GASTEROPODOUS–bulging on 1 side (like a stomach); see also *gibbous* and *ventricose.*

GEMINATE–in pairs.

GEMMA (pl. GEMMAE)–a small, globose, elliptic, or cylindric body of a few cells serving in vegetative reproduction (see also *brood-body* and *propagulum*); GEMMIFEROUS (GEMMIPAROUS)–bearing gemmae; GEMMIFORM (GEMMACEOUS)–bud-like.

GENICULATE–abruptly bent, like a knee.

GIBBOUS–swollen on 1 side above, resembling a hunched back.

GLABROUS–smooth.

GLAUCOUS–with a whitish, grayish, or bluish overcast (resembling the waxy bloom on a plum).

GLOBOSE–spherical.

GONIDIA–rarely used to refer to gemmae.

GONIAUTOICOUS–monoicous, with the male inflorescence small, gemmiform, and axillary.

GRANULOSE–roughened with minute, blunt projections, minutely grainy.

GREGARIOUS–growing close together but not in tufts or mats.

GUARD CELLS–the cells surrounding a stoma, usually paired and kidney-shaped, occasionally a single cell with a central slit.

GUIDE CELLS–large, empty, rather thin-walled cells in a median row as viewed in the cross-section of the costa of many mosses.

GUTTULATE–with cell lumina rounded because of strong wall thickening, having the appearance of drops of liquid.

GYMNOSTOMOUS–lacking a peristome.

GYNOECIUM–the female inflorescence (more often applied to hepatics).

GYRATE–circinate, coiled.

HABIT–the aspect or general appearance of a plant.

HABITAT–environment.

HAMATE–hooked.

HASTATE–abruptly broadened and auriculate at base, shaped like an arrow.

HELICOID–spirally twisted.

HELIOPHILOUS–preferring sunny places, photophilous.

HETEROGENEOUS–dissimilar.

HETEROICOUS–with several forms of inflorescence on the same plants (or various plants of the same species); also called *polyoicous* and *polygamous.*

HETEROMALLOUS–pointing in all directions (opposed to *homomallous,* all pointing the same way).
HISPID–with short, stiff hairs, bristly.
HOARY–whitish or grayish.
HOMOGENEOUS–uniform.
HOMOMALLOUS–pointing the same way.
HUMICOLOUS–growing on the ground.
HYALINE–colorless and transparent.
HYALOCYST–in *Sphagnum* leaves, a large, empty, colorless water-storage cell enclosed in a network of green chlorocysts; also called *hyaline cells.*
HYALODERM–in *Sphagnum,* a cortex of large, empty, colorless cells.
HYDRIC–very wet or aquatic; HYDROPHYTE–an aquatic plant, growing submerged or floating; HYDROPHILOUS–in water, submerged or floating.
HYDROIDS–tracheid-like conductive cells in the axial strand of many mosses, sometimes also in the costa but not usually in contact with the central strand.
HYGROPHYTE–a plant of wet habits but not in water; HYGROPHILOUS–adapted to wet (but not aquatic) habitats.
HYGROSCOPIC (HYGROMETRIC)–changing position with a change in humidity, readily absorbing moisture.
HYPNOID PERISTOME–a "perfect" double peristome, with 16 lanceolate teeth, cross-striolate at base and trabeculate at back and a well-developed endostome consisting of a high basal membrane and 16 lanceolate, keeled segments alternating with 1 or more cilia.
HYPOPHYSIS–a conspicuous swelling or expansion of the neck of the capsule (also called an *apophysis*)

IMBRICATE–closely appressed and overlapping.
IMMARGINATE–without a border.
IMMERSED–completely covered; immersed capsules are exceeded by the tips of the perichaetial leaves; immersed stomata have guard cells ± sunken below the level of the exothecial cells.
INAPERTURATE SPORES–lacking "apertures" or thin spots in the exine (the most common type of moss spore).
INCISED–cut into sharp divisions separated by narrow sinuses.
INCLINED CAPSULES–less than vertical, between erect and horizontal.
INCLUDED–enclosed, not reaching the surface or extending beyond the surrounding organs.
INCOHERENT–rarely used to describe loose tufts (which become separated on collection).
INCRASSATE–thickened.
INCURVED–curved upward and inward, applied to leaf tips and margins.
INDEHISCENT–without an operculum.
INFLATED–swollen.
INFLEXED–bent upward and inward, applied to leaf margins (opposed to *reflexed,* bent under and inward).
INFLORESCENCE–a cluster of sex organs and the leaves or bracts surrounding them.
INNOVATION–a new shoot, a branch formed after the maturity of sex organs, usually at the base of an inflorescence.
INSERTION–the place of attachment of a leaf, branch, or peristome.
INTRICATE–interwoven, tangled.
INVOLUTE–inrolled, applied to leaf margins (opposed to *revolute*).
ISODIAMETRIC–about as broad as long (including square, rounded, or hexagonal).
ISOPHYLLOUS–in *Sphagnum,* stem and branch leaves similar; HEMI-ISOPHYLLOUS–stem leaves not greatly differentiated.

JUGUM (pl. JUGA)–a pair of leaves, rarely applied to leaves of *Fissidens.*
JULACEOUS–smoothly cylindric, like a worm or a catkin, referring to stems or branches with crowded and imbricate leaves.

KEELED–sharply folded along the middle, like the keel of a boat, carinate.

LACERATE–deeply and irregularly slashed or torn.
LACINIATE–dissected into fine, deep, irregular divisions (*laciniae*), ciliate-fringed.
LACUNOSE–with irregular lumina because of deeply porose cell walls, or perforated, sometimes referring to cells with very thick walls (the lumina resembling a blank space or cavity).
LAMELLAE–green ridges or plates on the costa or lamina of some moss leaves.
LAMINA (Pl. LAMINAE)–the leaf blade (as distinguished from the *costa*).
LANCEOLATE–lance-shaped, narrow and tapered from the base (narrower than *ovate*).
LANUGINOSE–woolly, tomentose.

LATERAL–at the side; opposed to *terminal.*
LAX–soft or loose, usually referring to large thin-walled cells.
LEAF TRACE–a continuation of cells of the midrib through the cortex to the axial strand; if present at all, usually ending blindly in the cortex as *false leaf traces.* True leaf traces occur in some species of *Polytrichum.*
LENTICULAR (LENTIFORM)–doubly convex, lens-shaped.
LEPTODERMOUS–thin-walled, referring to leaf cells and also to capsules with soft or delicate walls (opposed to *pachydermous*).
LEPTOID–conductive cells in their best development similar to sieve tubes in form and function, found in the axial strand of stems and setae of polytrichaceous mosses and in setae of many other mosses.
LEPTOME–a phloem-like tissue consisting of leptoids and parenchymatous cells.
LEUCOCYST–the large, empty, hyaline leaf cells of *Sphagnum,* Leucobryaceae, and *Paraleucobryum* (also called *hyalocysts*).
LID–operculum.
LIGULATE–strap-shaped.
LIMB–the upper part of a leaf, contrasted with the base.
LIMBATE–bordered.
LINEAR–very narrow and elongate, with nearly parallel sides (narrower than *ligulate*).
LINGULATE–tongue-shaped, oblong with a broadened apex.
LOBE–a major division of a leaf; LOBULE–a small, basal division of a *bilobed* leaf.
LORICATE–equally narrow throughout (referring to the appearance given by a corset or cuirass).
LUMEN (pl. LUMINA)–the cell cavity.
LUNATE (LUNULATE)–crescent-shaped.
LURID–wan or gastly pale, sometimes referring to a dingy yellow-brown color.

MACRONEMATA (sing. MACRONEMA)–large, freely branched rhizoids produced around branch primordia (Mniaceae).
MAMMILLA (pl. MAMMILLAE)–a bulging protuberance with a blunt, nipple-like tip; MAMMILLOSE (MAMMILLATE)–convex with a blunt central projection. (Note: also correctly spelled mamilla, mamillose, etc.)
MAT–a densely interwoven, horizontal form of growth (*cf. Hypnum*).
MEDIAN–middle; MEDIAN LEAF CELLS–cells in the upper middle of the leaf, in leaves with a well-developed costa, those between costa and margin about 2/3 up the leaf.
MEMBRANE GAPS–irregular openings in the outer cells of hyaline cells of *Sphagnum* stem leaves.
MERISTEM–the growing point or a zone of continuing growth.
MESIC–moist, neither very wet nor very dry but intermediate; MESOPHYTIC–adapted to a temperate climate or a relatively moist habitat.
MESOTROPHIC–more or less neutral in reaction, neither acid nor basic (cf. *eutrophic* and *oligotrophic*).
MICRON (pl. MICRA)–one-thousandth of a millimeter (represented by the Greek letter $\mu$).
MICRONEMATA (sing. MICRONEMA)–minute club-shaped hairs, resembling paraphyses, borne in leaf axils in some Mniaceae, Meesiaceae, and Splachnaceae; small rhizoids produced on stems, leaf decurrencies, costae, or laminae, smaller and less branched than macronemata (Mniaceae).
MIDRIB–a mid-vein or single costa.
MITRATE (MITRIFORM)–conic and undivided or equally lobed at base, similar to a bishop's miter, referring to calyptrae (opposed to *cucullate* or split on 1 side).
MONILIFORM–resembling a string of beads.
MONOICOUS–with antheridia and archegonia on the same plant, including autoicous, synoicous, paroicous, and polyoicous (opposed to *dioicous*).
MONOLETE SPORES–having a single scar on the surface of the exine (as in *Funaria hygrometrica* and *Bryum caespiticium*).
MONOPODIAL BRANCHING–differentiation into primary and secondary shoots (or stems and branches).
MORPHOLOGY–form, structure.
MUCRO–a short, abrupt point; MUCRONATE–ending abruptly in a short point usually caused by a shortly excurrent costa; APICULATE indicates a somewhat longer tip and CUSPIDATE a longer, stouter, tooth-like tip.
MULTI-–prefix meaning many, as in *multicellular.*
MURICULATE–roughened with minute, sharp points (diminutive of *muricate*).
MUTICOUS–without a point or awn.

NANANDRY–sexual dimorphism, with male plants dwarfed, see also *phyllodioicous* and *pseudomonoicous.*
NAVICULAR–boat-shaped.
NECK–the sterile basal portion of a capsule, sometimes considerably differentiated.
NERVE–costa.
NIDULANT–nesting, rarely used to refer to the bud-like plants of *Ephemerum* nested on an abundant protonematal mat.
NITROPHILOUS–preferring substrata rich in nitrogenous compounds.
NODOSE–with knob-like thickenings; NODULOSE–minutely knobbed.
NUTANT–nodding, drooping.

OB-–a prefix indicating inversion, as in *obovate* (egg-shaped, with the broader portion at the apex rather than the base), *obconic, obcordate,* etc.
OBLATE–wider than long.
OBLONG–rectangular.
OBSCURE–dark, indistinct.
OBSOLETE–scarcely evident, almost lacking (usually referring to the costa).
OBTUSE–broadly pointed (more than 90°)–used by some authors to mean blunt or rounded.
OCHRACEOUS–brownish-yellow.
OCREA (pl. OCREAE)–a thin, filmy sheath terminating the vaginula, rarely noticeable.
OLIGO-–a prefix denoting few; OLIGOPOROUS–with a few pores; OLIGOTROPHIC–poor in minerals, hence acid in reaction (opposed to *eutrophic*).
OLIVACEOUS–olive-green.
OPAQUE–dark, not transparent or translucent.
OPERCULUM–the lid covering the mouth of a moss capsule, falling at maturity to release the spores.
ORAL–referring to the mouth of a capsule.
ORBICULAR–nearly circular.
ORIFICE–mouth of a capsule.
OVAL–shortly elliptic.
OVATE–egg-shaped (with the base broader than the apex).
OXYLOPHILE (OXYLOPHYTE)–a plant of acid habitats, an acidophile.

PACHYDERMOUS–thick-walled, referring to cell walls or to firm and tough or leathery capsules.
PALMATE–with finger-like lobes radiating from the center.
PANDURIFORM–shaped like the body of a violin (obovate with a sinus on either side).
PAPILLA–a minute protuberance of various forms; PAPILLOSE–roughened by 1 to many minute protuberances.
PARAPHYLLIA–small, green, filiform, lanceolate, or leaf-like, sometimes branched scales often produced on stems or branches of pleurocarpous mosses; PSEUDOPARAPHYLLIA–paraphyllia-like structures restricted to the branch insertions.
PARAPHYSES–hyaline or yellowish, septate hairs mingled with the antheridia (and often with archegonia).
PARENCHYMA–a tissue of relatively undifferentiated cells, usually thin-walled and isodiametric (hence with broad ends); PARENCHYMATOUS–composed of ± short cells joined end to end (opposed to *prosenchymatous*).
PAROICOUS–with antheridia and archegonia in the same inflorescence but not mixed, the antheridia in the axils of uppermost and perichaetial leaves.
PATENT–spreading at 45° or more (used by some authors to mean spreading at 26-45°, *patulous* meaning 46-90°).
PECTINATE–resembling a comb.
PEDICEL–the stalk or seta on which the capsule is borne.
PELLUCID–clear, translucent or transparent.
PELTATE–shield-like, flat and attached by a stalk on the underside.
PENDENT–hanging; PENDULOUS–somewhat drooping, inclined more than horizontally; with stems and branches hanging, a growth form common in tropical cloud forests.
PENICILLATE–like an artist's brush.
PERCURRENT–extending to the apex.
PERFECT PERISTOME–see *hypnoid peristome.*
PERICHAETIUM–the female inflorescence, consisting of leaves or bracts surrounding the archegonia, opposed to the male inflorescence (*perigonium*).
PERIGONIUM–the male inflorescence, a cluster of leaves or bracts surrounding the antheridia.
PERISTOME–a single or double circle of teeth inside the mouth of the capsule, the outer peristome (or *exostome*) consisting of *teeth,* the inner peristome (or *endostome*) consisting of *segments,* sometimes alternating with *cilia,* often rising from a *basal membrane.*

PHANEROPORE–with superficial stomata, that is, the guard cells at the same level as other exothecial cells and not sunken in chambers (opposed to *cryptopore*).
PHOTOPHILOUS–preferring well-lighted habitats, *heliophilous*; opposed to *sciaphilous.*
PHYLLODIOICOUS–nanandrous; with dwarf male plants which rest on leaves or tomentum of the larger female plants.
PHYLLOTAXY–the arrangement of leaves in spirals on a stem, formerly referred to as *dispositio*; *e.g.*, disp. 3/8 means that 8 leaves occupy 3 complete turns, and disp. 2/5 means that 5 leaves occupy 2 turns of the spiral.
PILIFEROUS–hair pointed.
PILOSE–long-hairy.
PINNATE–with numerous, spreading branches on 2 sides of the axis and thus resembling a feather.
PITTED–with small openings or pores through the walls of adjoining cells, sometimes marked by conspicuous depressions in thick-walled cells, also called *porose.*
PLANE–flat.
PLEUROCARPOUS–producing the sporophytes laterally (from a mere perichaetial bud or a short, specialized branch) rather than at the stem tip; PLEUROCARPOUS mosses are usually prostrate and freely branched and grow in mats rather than tufts.
PLICATE–folded in longitudinal pleats (*plicae*).
PLUMOSE–closely and regularly pinnate, feathery.
PLURI-–a prefix denoting many, as in *pluripapillose, pluriseriate,* or *pluristratose.*
POLYEDAPHIC–occurring on many kinds of substrates.
POLYGAMOUS–with antheridia and archegonia in separate inflorescences and also mixed together on the same plants (also called *polyoicous* and *heteroicous*).
POLYMORPHOUS (POLYMORPHIC)–of many forms, variable.
POLYOICOUS–see polygamous.
PORES–small openings or "pits" in the walls of some cells, sometimes conspicuous as depressions in thick walls between adjacent cells; in *Sphagnum* the pores are particularly large and conspicuous in the exposed walls of the hyaline cells of branch leaves and also in outer stem cells; porose cell walls may be minutely or quite obviously perforated.
PREDOMINANT–very conspicuous, prominent.
PRIMARY STEM–the main stem, often creeping or rhizome-like with reduced or scale-like leaves.
PRIMORDIAL UTRICLE–referring to the cytoplasmic membrane which is sometimes particularly noticeable as a result of shrinkage from the cell wall on drying.
PROCESSES–segments of the endostome.
PROCUMBENT–spreading, prostrate.
PROLIFEROUS–continuing growth by the production of a new stem (or *innovation*).
PROPAGULUM (pl. PROPAGULA)–reduced bud, branch, or leaf serving in vegetative reproduction (see also *brood body*).
PROSENCHYMATOUS–with narrow, elongate cells overlapping at the ends opposed to *parenchymatous*); PROSENCHYMA–a tissue made up of elongate cells with tapered ends.
PROSTRATE–creeping.
PROTEAN–exceedingly variable.
PROTONEMA (pl. PROTONEMATA)–green, branched filaments produced on germination of spores and giving rise to a leafy or thallose gametophyte; in *Sphagnum, Andreaea,* and the liverworts, the protenema is ± thallose rather than filamentous; *secondary protonemata* are sometimes also produced on leaves or stems of mosses, sometimes at wounds (broken leaves, for example).
PROTONEMATOUS RHIZOIDS–macronemata capable of producing protonemata if detached from stems (Mniaceae).
PSEUDO-–a prefix denoting false; PSEUDANNULUS–an apparent annulus consisting of small, non-vesiculose cells; PSEUDAUTOICOUS or PSEUDOMONOICOUS–with dwarf males growing on female plants; PSEUDOPARAPHYLLIA–small, unistratose, lanceolate or filiform structures resembling paraphyllia, often found in pleurocarpous mosses in small numbers around branch primordia (or persisting at branch bases); PSEUDOPODIUM–an elongation of the gametophytic axis below the sporophyte in *Sphagnum* and *Andreaea,* serving the function of a seta; also applied to a similar extension of a stem tip bearing clusters of gemmae; PSEUDOPORE–small spots somewhat resembling pores in hyaline cells of *Sphagnum* branch leaves, consisting of fibril rings not enclosing a perforation; PSEUDOSTOMATA–in *Sphagnum* capsules, vestigial stomata, consisting of two guard cells but no pore.
PUGIONIFORM–dagger-shaped.
PULVINATE–cushion-like.
PUNCTATE–dotted, usually referring to spore markings; PUNCTULATE–minutely dotted.
PUNGENT–ending in a stiff or hard point.
PYRIFORM–pear-shaped.

QUADRATE–square.
QUINQUEFARIOUS–in 5 rows.

RADICLES–rhizoids, slender, non-chlorophyllose threads attaching the plants to the substrate, often covering stems, occasionally growing from leaf tips; the radicles of mosses have oblique cross-walls; RADICULOSE–covered with rhizoids.
RAMENTUM–a woolly covering or tomentum, made up of radicles.
RAMULI (sing. RAMULUS)–the smaller divisions of a much branched plant; RAMULOSE–with small branches.
RANK–row.
RECEPTACLE–an expanded and ± elevated structure bearing sex organs and eventually sporophytes in the Marchantiaceae, rarely used in the Musci to refer to the tissue on which the reproductive organs are borne.
RECURVED–curved downward or backward, referring to leaf margins or tips, marginal teeth, or peristome teeth.
REFLEXED–bent backward.
REGULAR–symmetric.
RENIFORM–kidney-shaped.
REPAND–slightly sinuose.
REPENT–creeping.
RESORPTION–disappearance or erosion of parts of cell walls in *Sphagnum* leaves; RESORPTION FURROW–a furrow produced by the disappearance of the outer cell walls at the leaf margins of some species of *Sphagnum*, best seen in cross-section.
RETICULATE–in a network.
RETORT CELLS–cells with a pore at the upper end, terminating a short, projecting neck, found in the cortex of branches in many species of *Sphagnum*.
RETUSE–slightly indented at a broad apex.
REVOLUBLE–rolling away, referring to an annulus which falls in a ring; REVOLUTE–rolled downward and backward, referring to leaf margins.
RHIZAUTOICOUS–monoicous, with the male inflorescence on a very short branch attached to the female stem by rhizoids and thus appearing to be a separate plant.
RHIZOIDS–simple or branched, septate filaments, dead at maturity, anchoring the plant and sometimes ± covering the stem (see also *radicles*).
RHIZOME–a slender, horizontal, subterranean, root-like stem.
RHOMBIC–diamond-shaped; RHOMBOIDAL–longer than rhombic, oblong-hexagonal.
RIMOSE–chinky.
ROSTRATE–beaked; ROSTELLATE–shortly or minutely beaked.
ROSULATE–like a rosette, referring to leaves enlarged and crowded at tips of stems and resembling small flowers.
ROTUND–round.
RUFOUS–reddish.
RUGOSE–transversely wrinkled or undulate; RUGULOSE–slightly wrinkled crosswise.
RUPESTRAL–growing on rocks (also called *saxicolous*).

SACCATE–abruptly and deeply concave, forming a sack.
SAPROPHYTE–living on dead organic matter, opposed to *parasite*.
SAXICOLOUS–growing on rocks (*rupestral*).
SCABROUS–rough.
SCALARIFORM–ladder-like.
SCALPELLIFORM–asymmetric and resembling the blade of a pen-knife.
SCARIOUS–dry and thin, scale-like or membranous.
SCIAPHILOUS–preferring shady habitats.
SCLERODERM–the thick-walled cells forming a woody cylinder in stems and branches of *Sphagnum*.
SECUND–turned to 1 side.
SEGMENTS–the tooth-like divisions of the inner peristome, sometimes called *processes*.
SEPTATE–divided by cell walls, having partitions.
SERIATE–in rows.
SERRATE–saw-toothed, with marginal teeth pointing forward; DOUBLY SERRATE–with teeth overlapping and joined in pairs; SERRULATE–minutely serrate.
SESSILE–without a stalk or seta, hence *immersed*.
SETA–the stalk supporting the capsule.
SETACEOUS–bristle-like.
SHEATHING–± surrounding and clasping the stem or the base of the seta.
SHOULDER–the area where a leaf base is abruptly narrowed to the limb.

SIGMOID–somewhat S-shaped.
SILICEOUS–having a high silicon content, sandy (usually poor in bases); SILICICOLOUS–growing on sandstone or other siliceous rock.
SINISTRORSE–twisted to the left.
SINUATE (SINUOSE)–wavy; SINUOLATE–minutely or slightly wavy.
SINUS–a depression between two lobes or prominences, the identation between lobes of a leaf (liverworts).
SORDID–of a dirty or muddy color.
SPATULATE–tapered from a broad, rounded apex (similar to lingulate but more abruptly narrowed from a broad apex).
SPICULOSE–sharply and minutely toothed or papillose.
SPINDLE-SHAPED–fusiform; narrow, elongate, and tapered at both ends.
SPINOSE–spiny, with sharp, slender teeth or projections; SPINULOSE–minutely spiny.
SPORANGIUM–the spore-sac of a capsule or, more loosely, the entire capsule.
SPORES–minute, mostly spherical, nearly always unicellular bodies produced in the capsule as a result of reduction division, giving rise on germination to protonemata.
SPOROPHYTE–the spore-bearing generation; the spore-bearing plant, produced by the fertilization of an egg, remaining attached to the gametophyte and partially dependent on it, typically consisting of foot, seta, and capsule.
SPREADING–at an angle of 45° or more; *wide-spreading* means nearly 90°, *squarrose* 90°, *squarrose-recurved* 90° with recurved tips.
SQUALID–sordid or dirty.
SQUARROSE–spreading at right angles; SQUARROSE-RECURVED–spreading at right angles, with the tips curved downward.
STEGOCARPOUS–with operculum differentiated (opposed to *cleistocarpous* or *astomous*).
STELLATE–star-shaped.
STEREIDS–slender, elongate, thick-walled, fiber-like cells found in groups in the costa of some mosses; also applied to linear, thick-walled border cells.
STERILE–barren, not fertile, lacking sporophytes.
STIPE–the unbranched base of a dendroid or frondose plant; STIPITATE–with a trunk-like base.
STOLONIFORM–referring to slender, elongate, spreading branches or stems, with smaller and otherwise differentiated leaves and often radiculose or "rooting" near the tips, resembling runners or stolons of a strawberry, for example.
STOMA (pl. STOMATA)–opening in the capsule wall, usually in the neck, surrounded by guard cells.
STRAMINEOUS–straw-colored.
STRANGULATE–deeply constricted below the mouth of a capsule.
STRIATE–marked with fine, longitudinal ridges (*striae*); STRIOLATE–finely ridged.
STRICT–straight and rigid.
STRUMOSE–with a goiter-like swelling (or *struma*) at the base, applied to some capsules; STRUMULOSE–with a small or indistinct swelling at 1 side of the capsule base.
SUB-–a prefix meaning nearly, almost, somewhat, as in *subacute, subentire, subpercurrent,* or *subquadrate*; also used to mean under, as in *submedian, subinvolucral.*
SUBULA–a long, slender point; SUBULATE–slenderly long-acuminate, shaped like a needle or awl.
SULCATE–strongly plicate, with deep longitudinal folds (more extreme than striate).
SURCULUS–a sucker-like outgrowth, rarely used to refer to upright secondary stems arising from a horizontal primary stem or "rhizome."
SUTURE–a line formed by the junction of 2 parts.
SYNOICOUS–with antheridia and archegonia mingled in the same inflorescence.
SYSTYLIOUS–with the operculum remaining attached to the tip of the columella after dehiscence.

TEETH–divisions of a single peristome or of the exostome of a moss with a double peristome; divisions of the endostome are called *segments* or *processes.*
TENIOLAE–the intramarginal border of linear cells in the leaves of *Calymperes.*
TERETE–rounded in cross-section, cylindric.
TERRESTRIAL–growing on the ground, *terricolous.*
TESSELLATED–checkered, in a pattern of squares, applied to the basal membrane of *Tortula.*
TETRAD–a group of 4 developing or rarely mature spores; because of development in tetrads some mature spores are ellipsoidal, angular, or ± kidney-shaped, sometimes *tetrahedral.*
THALLOSE–flat, not much differentiated, and cordate or ribbon-like in body form.
TOMENTOSE–woolly, densely radiculose, covered by a *tomentum* of rhizoids.
TOOTH–a division of the outer peristome; also applied to irregularities or projections at the margins of leaves.
TORTUOSE–irregularly bent or twisted.

TRABECULATE–with projecting cross-bars (*trabeculae*) at the back of some peristome teeth.
TRI-–a prefix meaning thrice; TRIGONOUS, TRIQUETROUS–3-cornered; TRIFARIOUS, TRISTICHOUS–in 3 rows.
TRIGONES–thickened corners of cells.
TRILETE SPORES–having a 3-pronged scar on the wall (as in *Sphagnum*).
TRIRADIATE–3-pronged, often used to refer to the scar of a trilete spore.
TRUNCATE–abruptly cut off or squared off at the apex.
TUBULOSE–tube-like, usually referring to leaves with strongly incurved margins.
TUFA–a porose limestone formed by deposition from calcareous waters (often formed because of the $CO_2$ relationships–in photosynthesis and respiration–of mosses).
TUMID–swollen, inflated.
TURBINATE–top-shaped.
TURF–a tufted form of growth, with stems erect and parallel, often in extensive clones.
TURGID–plump or swollen.

UMBONATE–convex with an abrupt, rounded, central point.
UMBRACULIFORM–umbrella-like.
UNCINATE–hooked.
UNDULATE–wavy; RUGOSE is a more extreme condition.
UNEQUAL–asymmetric.
UNGUICULATE–ending in a point similar to an animal's claw.
UNI-–a prefix meaning 1, as in *unipapillose, unistratose,* or *uniseriate.*
URCEOLATE–urn-shaped, applied to capsules constricted below a wide mouth and abruptly narrowed at the base.
URN–the spore-bearing portion of a capsule, as opposed to the sterile neck.
UTRICLE–a vesicle, rarely used to refer to the enlarged cortical cells of *Sphagnum* (see also *primordial utricle*).

VAGINATE–sheathing; VAGINANT LAMINA–in *Fissidens,* the expanded lamina at base of the leaf which clasps the stem and the base of the leaf above it.
VAGINULA–the ring or sheath enveloping the base of the seta, derived from the base of the archegonium and remaining after the separation of the calyptra.
VALVE–one of the segments into which a capsule separates on dehiscence; among Bryophyta, applied only to some liverworts and the Andreaeobrya.
VENTER–the swollen basal portion of an archegonium, containing the egg.
VENTRAL–the inner surface of a peristome tooth, the upper (*adaxial*) surface of a moss leaf, or the lower surface of a prostrate stem or thallus.
VENTRICOSE–bulging on 1 side below (like a stomach).
VERMICULAR–narrowly cylindric and curved, like a worm.
VERRUCULOSE–irregularly roughened.
VESICULOSE–inflated, bladder-like.
VILLI (sing. VILLUS)–paraphyllia.
VITTATE–striped.

WEFTS–a loosely interwoven, often ascending growth form (as in *Thuidium*).
WHORLED–arranged in a ring or circle.
WIDE-SPREADING–spreading at a wide angle but less than 90° (which is squarrose).

XERIC–very dry; XEROMORPHIC–structurally adapted for dryness; XEROPHILOUS–preferring dry places; XEROPHYTE–a plant of dry, often hot places.

ZYGOMORPHIC–bilaterally symmetric.

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# INDEX

## Subject Index


Allergies 338
Antibiosis 33
Arthropod association 339; tardigrades 339

Bog iron 292

Calyptra, function 135
Chemosynthesis 119
Chromosomes 166, 196; counting 134

Dispersal mechanisms 18, 51, 52, 70, 82, 93, 97, 119, 137-138, 143-144, 150-151, 181, 302, 311-313, 349, 351; insect dispersal 143-144; vagabonds (moss balls) 93
Distribution 62, 71, 302; nunataks 62
Dwarf males 84, 298

Ecology and habitats 1, 18-19, 53-54, 66, 70, 99, 108, 119, 125, 127, 133, 136-137, 139-150, 152, 159, 165, 251, 304, 339, 347, 357-358; bogs and bog succession 18-19, 358; cave mosses and liverworts 144-148; copper mosses 119, 165; dung mosses 141-144; ephemerals 119, 133, 139, 140; nitrophiles 159; pioneers 70, 125, 136, 139, 347; sand-binders 127; submerged mosses 53-54; weeds 137, 149-150, 159
Environmental conditions 18-19, 33; acidity 18, 137; alkalinity 137; cold 138, 153; ion-exchange 18; water relations 33, 125, 138
Evolution 133-134, 143-144, 166, 214, 221, 362-364; methods of study 196; reduction 133, 362-364; speciation 134, 166, 354

Fawley buns 93
Food: caloric and vitamin content 338; odor 143, 144, 338; taste 338
Fungal infection (Tilletia sphagni, Helotium schimperi) 23

Genetics 84, 133-134, 298, 354
Glacier mice 93
Goblin Gold 146-148

Limestone deposits: didymodontoliths 108; travertine 108; tufa 108, 251, 292
Leaves: Fissidens 52; isophylly 39, 46; phyllotaxy 221
Leskeaceae, family concept 224
Luminescence 146-148

Manna 93
Maturation cycles 84-85, 304
Mineral uptake 119, 165
Moss balls 93

Park, Mungo 61-62
Peristomes 121, 181, 224, 311-312, 325; hypnaceous 224, 325; perfect 224, 325; structure and development 70, 148, 182-183
Photoperiod 85, 152
Phototropism 135, 348
Pygmies 66

Regeneration 134, 137-138; apogamy 133; apospory 133, 166
Reproduction: asexual 119, 125, 137, 138, 160; hybrids 66, 102, 133; sexual 119, 129, 153, 298, 302-304; sexual dimorphism 84, 143, 298, 348; sterility 302-304

Saprophytes: Cryptothallus 42; Buxbaumia 347
Seeding 330, 357
Sphagnum, classification 17; ecology 18-19; fungal infection 23; ion-exchange 18; isophylly 39, 46; keys 19; microspores 23; spores 18; surgical pads 33; uses 19; variability 39, 46, 48, 60; water relations 33
Spores 18; germination 51, 125; dimorphism 143; microspores 23; numbers 70-71; palynology 18; viability 137
Succession: bog 18-19, 358; fire 70, 136, 137, 304, 347, 357; pioneers 70, 125, 136, 139, 347; rock 125; soil 150

Taxonomy: cytotaxonomy 166, 196; methods of study 39, 166, 196, 298; variability 39, 46, 48, 60, 69, 100, 124-125, 267-268
Thuidiaceae, family concept 224

Uses 19, 328, 337-339; decoration 328, 337; nesting material 152; gardens 338

Vascular tissue 214, 362; lignin 362


## Taxonomic Index


Acaulon muticum var. rufescens 119
Aloina brevirostris 119
rigida 119
Amblyodon dealbatus 186
Amblystegium serpens 261
serpens var. juratzkanum 261
varium 261
Amphidium lapponicum 208
mougeotii 208
Anacamptodon splachnoides 222
Andreaea rothii 50
rupestris 50

Anomodon attenuatus 233
minor 234
rostratus 233
rugelii 234
viticulosus 235
Aphanorrhegma serratum 133
Apple Moss 193
Astomum muhlenbergianum 102
Atrichum angustatum 353
crispum 355
undulatum 353
var. altecristatum 355
var. oerstedianum 355
var. undulatum 355
Aulacomnium acuminatum 185
androgynum 184
heterostichum 182
palustre 184
turgidum 185

Barbula convoluta 109
fallax 111
michiganensis 111
reflexa 111
unguiculata 109
Bartramia ithyphylla 193
pomiformis 192
Bird Wheat 355
Blindia acuta 65
Bog Moss 17
Brachythecium acuminatum 286
acuminatum var. crytophyllum 287
campestre 289
curtum 290
digastrum 288
oxycladon 287
fo. falcatum 288
plumosum 285
populeum 285
reflexum 284
rivulare 291
rutabulum 290
salebrosum 288
turgidum 289
velutinum 284
Brook Moss 213
Broom Moss 85
Brotherella recurvans 313
tenuirostris 314
Bruchia flexuosa 78
Bryhnia graminicolor 293
novae-angliae 293
Bryoandersonia illecebra 296
Bryoerythrophyllum recurvirostrum 105
Bryoxiphium norvegicum 62
Bryum algovicum 158
argenteum 159
caespiticium 162
capillare 159
var. flaccidum 160
cryophilum 162
lisae var. cuspidatum 162
muehlenbeckii 164
pallens 164
pseudotriquetrum 161
tortifolium 162
uliginosum 158
weigelii 161
Bug-on-a-Stick 347
Buxbaumia aphylla 346
minakatae 348

Callicladium haldanianum 311
Calliergidium pseudostramineum 267, 273
Calliergon cordifolium 275
giganteum 273
richardsonii 275
stramineum 271
trifarium 273
Calliergonella cuspidata 277
Campylium chrysophyllum 253
hispidulum 251
polygamum 254
radicale 253
stellatum 254
var. protensum 255
Catoscopium nigritum 190
Cave Moss 144
Ceratodon purpureus 69
Cinclidium stygium 178
Cinderella 136
Cirriphyllum piliferum 294
Climacium americanum 336
dendroides 336
kindbergii 337
Common Fern Moss 245
Common Hair Cap Moss 360
Cord Moss 135, 136
Cratoneuron commutatum 251
filicinum 250
Cryptothallus mirabilis 42
Ctenidium molluscum 333
Cynodontium schisti 91
strumiferum 91
torquescens 91

Desmatodon obtusifolius 115
Dichelyma capillaceum 217
falcatum 217
pallescens 217
Dichodontium pellucidum 90
Dicranella cerviculata 76
grevilleana 75
heteromalla 75
schreberiana 75
var. robusta 75
subulata 76
varia 76
Dicranoweisia crispula 92
Dicranum bonjeanii 85
drummondii 86
flagellare 82
fragilifolium 81
fulvum 81
fuscescens 86
majus 86
montanum 82
polysetum 82
sabuletorum 88
scoparium 85

spurium 87
undulatum 89
viride 80
Didymodon rigidulus 106
tophaceus 108
Diphyscium foliosum 348
Distichium capillaceum 67
inclinatum 67
Ditrichum flexicaule 72
flexicaule var. densum 72
var. sterile 72
lineare 72
pallidum 73
pusillum 73
rhynchostegium 73
Drepanocladus aduncus 266
aduncus fo. capillifolius 267
var. kneiffii 267
var. polycarpus 266
fo. gracilescens 267
exannulatus 268
fo. brachydictyus 268
fo. tundrae 268
var. alpinus 268
var. purpurascens 268
var. rotae 268
fluitans 268
var. uncatus 270
revolvens 264
var. intermedius 264
sendtneri 267
trichophyllus 268
uncinatus 263
var. symmetricus 264
var. plumulosus 264
vernicosus 264
Drummondia prorepens 207
Dryptodon patens 128

Emerald Dewdrops 139
Encalypta ciliata 94
procera 97
rhaptocarpa 96
streptocarpa 97
vulgaris 96
Entodon cladorrhizans 305
seductrix 305
Entosthodon 135, 136
Ephemerum cohaerens 139
crassinervium 139
spinulosum 140
Eucladium verticillatum 100
Eurhynchium hians 298
pulchellum 296
riparioides 298
Extinguisher Moss 94

Fabronia ciliaris 223
Feather Mosses 325
Fern Mosses 240
Fissidens adiantoides 55
bryoides 60
bushii 58
cristatus 55
exiguus 60
exilis 59
fontanus 52
grandifrons 52
minutulus 60
obtusifolius 58
var. apiculatus 59
osmundoides 56
pusillus 60
subbasilaris 58
taxifolius 56
viridulus 60
Flapper Moss 170
Fontinalis antipyretica 216
dalecarlica 216
disticha 214, 216
hypnoides 214
var. duriaei 216
var. hypnoides 214, 216
neo-mexicana 216
novae-angliae 216
patula 216
sphagnifolia 216
Fork Moss 80
Forsstroemia trichomitria 209
Funaria americana 138
flavicans 138
hygrometrica 135

Goblin Gold 144
Golf Club Moss 190
Grimmia affinis 125
agassizii 124
alpicola 122
var. dupretii 124
var. rivularis 124
anodon 125
apocarpa 121
var. stricta 122
hartmanii var. anomala 125
pilifera 126
plagiopodia 124
pulvinata 126
torquata 126
unicolor 126
Gymnostomum aeruginosum 98
calcareum 99
recurvirostrum 99
var. commutatum 100
var. latifolium 100
Gyroweisia tenuis 99

Hair Cap Mosses 355
Haplocladium microphyllum 239
virginianum 240
Haplohymenium triste 236
Hedwigia ciliata 129
Helodium blandowii 247
blandowii var. helodioides 249
paludosum 249
Helotium schimperi 23
Herzogiella striatella 332
turfacea 332
Heterocladium dimorphum 231
Heterophyllium haldanianum 311
Homalia trichomanoides 220

Homomallium adnatum 319
Hump-backed Elves 346
Hygroamblystegium fluviatile 260
noterophilum 260
orthocladon 260
tenax 259
var. spinifolium 260
Hygrohypnum luridum 270
molle 271
ochraceum 271
Hylocomium brevirostre 344
pyrenacium 344
splendens 342
umbratum 344
Hyophila involuta 59, 108
Hypnum cupressiforme 327
curvifolium 330
fertile 330
imponens 328
lindbergii 325
pallescens 328
pratense 326
Hyssopus Salamonis 136

Isopterygiopsis muelleriana 323
Isopterygium distichaceum 322
elegans 322
pulchellum 322

Juniper Moss 357

Knight's Plume 334
Knothole Moss 223

La Charbonnière 136
Leptobryum pyriforme 149
Leptodictyum brevipes 257
riparium 256
fo. fluitans 256
fo. longifolium 256
trichopodium 258
var. kochii 258
Leskea gracilescens 226
obscura 226
polycarpa 226
Leskeella nervosa 227
Leucobryum albidum 93
glaucum 92
Leucodon brachypus var. andrewsianus 212
julaceus 211
Lindbergia brachyptera 238
Long-Neck Moss 78
Luminous Moss 144

Meesia longiseta 188
triquetra 187
uliginosa 187
Mielichhoferia mielichhoferi 165
Mnium affine
affine var. affine 173
var. ciliare 173
var. rugicum 173
andrewsianum 178
cinclidioides 175
cuspidatum 171
drummondii 172
longirostrum 174
lycopodioides 168
marginatum 169
medium 173
orthorrhynchum 169
pseudopunctatum 176
punctatum 176
var. elatum 176
spinulosum 170
stellare 167
Mountain Fern Moss 344
Myurella julacea 229
sibirica 229

Neckera pennata 219

Oncophorus virens 79
wahlenbergii 79
Orthotrichum alpestre 200
anomalum 199
obtusifolium 196
ohioense 201
pallens 200
pumilum 202
pusillum 202
sordidum 197
speciosum var. elegans 198
var. speciosum 199
stellatum 200
strangulatum 200

Paludella squarrosa 189
Paraleucobryum longifolium 89
Peat Moss 17
Petticoat Moss 142
Phascum cuspidatum 112
floerkeanum 112
Philonotis capillaris 194
fontana 194
marchica 194
Physcomitrella patens 133
Physcomitrium hookeri 133
immersum 133
pyriforme 131
Pin-Cushion Moss 93
Plagiomnium 166
Plagiopus oederiana 191
Plagiothecium cavifolium 307
denticulatum 309
laetum 308
latebricola 308
Platydictya confervoides 321
jungermannioides 319
subtile 321
Platygyrium repens 316
Pleuriditrichum marylandicum 66
Pleuridium palustre 66
subulatum 66
Pleurozium schreberi 302
Pogonatum alpinum 361
dentatum 361
pensilvanicum 361
urnigerum 361

Pohlia annotina 153
annotina var. annotina 153
var. decipiens 153
bulbifera 155
cruda 151
elongata 153
filiformis 156
lescuriana 155
nutans 152
proligera 154
rothii 155
wahlenbergii 155
Polytrichum commune 360
formosum 358
var. aurantiacum 358
juniperinum 356
var. affine 357
ohioense 359
piliferum 356
Pottia davalliana 113
truncata 113
var. major 115
Pottioideae 97
Powder Gun Moss 350
Pseudobryum 166
Pseudoleskea patens 226
radicosa 226
Pseudoleskeella tectorum 227
Pterigynandrum filiforme 230
filiforme var. montanense 230
Pterygoneurum ovatum 119
Ptilium crista-castrensis 334
Pylaisiella intricata 318
polyantha 317
selwynii 318
Pyramidula tetragona 139

Red-Mouthed Mnium 170
Rhabdoweisia crispata 90
Rhacomitrium aciculare 128
canescens 127
fo. ericoides 127
fasciculare 128
heterostichum 126
lanuginosum 127
patens 128
Rhizomnium 166
Rhodobryum roseum 164
Rhynchostegiella compacta 301
Rhynchostegium serrulatum 299
Rhytidiadelphus loreus 342
squarrosus 342
triquetrus 340
Rhytidium rugosum 345
Rose Moss 164
Rough Neck Moss 341

Saelania glaucescens 71
Schistostega pennata 144
Schwetschkeopsis fabronia 223
Scopelophila ligulata 119
Scorpidium scorpioides 278
turgescens 280
Seligeria calcarea 63
campylopoda 63
donniana 63
pusilla 65
recurvata 65
Sematophyllum demissum 314
Shaggy Moss 341
Silvery Bryum 159
Sphagnum sect. Acutifolia 18
sect. Cuspidata 18
sect. Palustria 18
sect. Polyclada 18
sect. Rigida 18
sect. Sphagnum 18
sect. Squarrosa 18
sect. Subsecunda 18
subg. Inophloea 17
subg.Litophloea 18
annulatum var. porosum 36
capillaceum 46
var. capillaceum 46
var. tenellum 46
var. tenerum 47
centrale 22
compactum 25
cuspidatum 34
fimbriatum 40
fuscum 45
girgensohnii 40
imbricatum 24
lindbergii 33
magellanicum 21
majus 36
palustre 24
papillosum 23
var. laeve 24
pulchrum 33
quinquefarium 364
recurvum 31
var. amblyphyllum 33
var. recurvum 32
var. tenue 32
riparium 30
russowii 42
squarrosum 27
subfulvum 45, 48
subnitens 48
subsecundum 38
var. contortum 39
var. inundatum 39
var. platyphyllum 39
var. rufescens 39
var. subsecundum 38
teres 28
warnstorfii 43
wulfianum 27
Splachnum ampullaceum 141
luteum 142
rubrum 142
sphaericum 144
Stair-Step Moss 344
Sword Moss 62

Taxiphyllum deplanatum 324
taxirameum 324
Tayloria acuminata 144

lingulata 144
serrata 144
splachnoides 144
Tetradontium brownianum 351
Tetraphis geniculata 351
pellucida 351
Tetraplodon angustatus 142
mnioides 142
Thamnobryum alleghaniense 337
Thelia asprella 238
hirtella 237
lescurii 238
Thuidium abietinum 243
delicatulum 245
var. radicans 245
minutulum 240
pygmaeum 242
recognitum 243
scitum 242
Tilletia sphagni 23
Timmia austriaca 180
megapolitana 180
var. bavarica 180
Tomenthypnum nitens 281
nitens var. falcifolium 282
Top Moss 132
Tortella fragilis 103
humilis 104
inclinata 105
tortuosa 103
Tortula intermedia 117
mucronifolia 116
norvegica 118
pagorum 118
papillosa 118
ruralis 117
Tree Moss 336
Trematodon ambiguus 78
longicollis 78
Triangular Woodreveler 341
Trichostomoideae 97
Trichodon cylindricus 74
Trichostomum tenuirostre 105

Ulota coarctata 204
crispa 204
hutchinsiae 205
Umbrella Moss 142
Undulating Catharine 354
Urn Moss 132

Water-Measuring Cord Moss 136
Water Moss 213
Wavy Catharinea 354
Weissia controversa 101
White Moss 93
Women's Heads 80

Zygodon viridissimus 207
viridissimus var. rupestris 207
var. viridissimus 207

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